MINING engineering

JANUARY 1961

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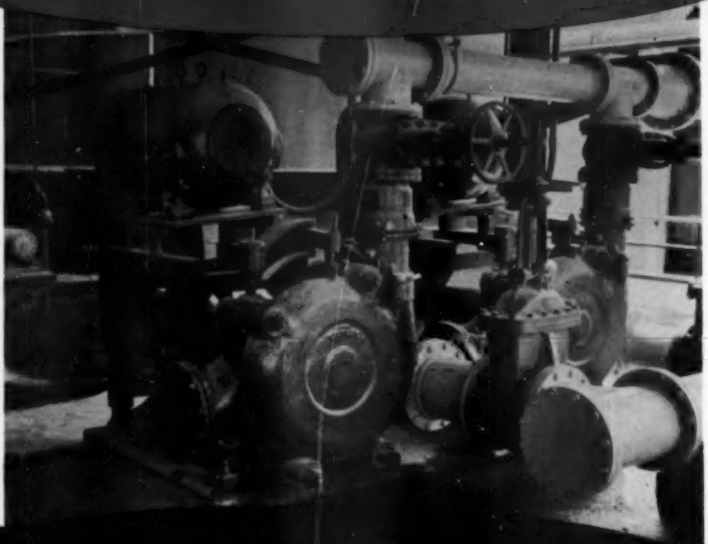

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COMING EVENTS

Feb. 22-25, International Symposium on Mining Research, sponsored by U.S. Bureau of Mines and Missouri School of Mines and Metallurgy, Rolla, Mo.

Feb. 26-Mar. 2, AIME Annual Meeting, Ambassador and Chase-Park Plaza Hotels, St. Louis.

Mar. 30-Apr. 1, Fourth Symposium on Rock Mechanics, sponsored by mining departments of Colorado School of Mines, University of Minnesota, Missouri School of Mines and Metallurgy, and The Pennsylvania State University. The Pennsylvania State University, University Park Pa.

Apr. 4-7, Short Course on computers and application for managerial and technical personnel in minerals industries. University of Arizona, Tucson. Address E. R. Drevdahl, College of Mines, University of Arizona.

Apr. 7-9, Sixth Annual Mining, Minerals, and Petroleum Conference, AIME Southwestern Alaska Section, Anchorage, Alaska.

Apr. 9-11, Society of Exploration Geophysicists 14th Annual Midwestern Meeting, Skirvin Hotel, Oklahoma City, Okla.

Apr. 10-11, ASME Maintenance and Plant Engineering Conference, Bancroft Hotel, Worcester, Mass.

Apr. 10-12, 44th National Open Hearth Steel Conference and Blast Furnace, Coke Oven, and Raw Materials Conference, Sheraton Hotel, Philadelphia.

Apr. 12-14, International Symposium on Agglomeration, sponsored by SME, SPE, and TMS of AIME, Sheraton Hotel, Philadelphia.

Apr. 20-22, 76th Annual Convention, Illinois Society of Professional Engineers, Peoria, Ill.

Apr. 23-26, ASME Metals Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

Apr. 24-25, Joint Meeting, AIME Southwest Mineral Industry Conference—SME Industrial Minerals Division, sponsored by AIME Nevada Section. Stardust Hotel, Las Vegas, Nev.

Apr. 26-27, AIME Technical Conference on High-Temperature Materials, Carter Hotel, Cleveland.

May 7-11, ASME—Engineering Institute of Canada Hydraulic Conference, Queen Elizabeth Hotel, Montreal.

May 12-14, Sixth Annual Uranium Symposium, sponsored by AIME Central New Mexico Section. Grants, N. M.

May 15-18, Coal Show of the American Mining Congress, Cleveland. Suggestions for topics to be included in program should be sent to American Mining Congress, Ring Bldg., Washington 6, D. C.

June 6-8, Sixth Annual Appalachian Underground Corrosion Short Course, West Virginia University School of Mines, Morgantown, W. Va. For information write John H. Alm, Publicity Chairman, Dearborn Chemical Co., 2 Gateway Center, Pittsburgh 22, Pa.

June 6-8, National Coal Assn., 44th Annual Meeting, Mayflower Hotel and Coal Bldg., Washington, D. C.

Jun. 28-30, Joint Automatic Control Conference, University of Colorado, Boulder, Colo.

Aug. 28-Sept. 1, International Heat Transfer Conference, University of Colorado, Boulder, Colo.

Sept. 11-13, American Mining Congress Metal Mining—Industrial Minerals Convention, Seattle, Wash.

Sept. 17-20, Commemoration of the 50th Anniversary of Froth Flotation in the U.S.A., sponsored by AIME: Society of Mining Engineers' Mineral Beneficiation Division, Cosmopolitan Hotel, Denver.

Oct. 5-7, Joint Solid Fuels Conference, Birmingham, Ala.

MINING engineering

SOCIETY OF MINING ENGINEERS AIME

VOL. 13 NO. 1 **JANUARY 1961**

COVER *Now approaching completion, the driving of the American Tunnel at Silverton, Colo., provided artist Herb McClure with this month's cover subject. Further details of the Silverton Project begin on page 28, this issue.*

ARTICLES

DEPARTMENTS

FEATURED ITEMS

ABC

NOTE and COVER ART

NOTE: SME Program and Abstract Section for the 1961 Annual Meeting in St. Louis appears on page 1239, December Issue.

Reproductions of the cover, without logo and suitable for framing are available. Cost: $1. Write (enclosing payment with request) to MINING ENGINEERING, 29 W. 39th St., New York 18.

MINING ENGINEERING staff, Society of Mining Engineers, and AIME Officers are listed on the *Drift* page.

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PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This service, which cooperates with the national societies of Civil, Chemical, Electrical, Mechanical, Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular placement fee. Upon receipt of your application a copy of our placement fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number. When making application for a position include 8¢ in stamps for forwarding application. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance. Local offices of the Personnel Service are at 8 W. 40 St., **New York 18,** 57 Post St., **San Francisco;** 29 E. Madison St., **Chicago 1.**

In addition to the listings below, ESPS maintains a more complete file of general engineering positions and men available. Contact nearest ESPS office, listed above.

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For details write:

C. S. Warner
State Personnel Board
801 Capitol Avenue
Sacramento 14, California

MEN AVAILABLE

President, Executive Vice President or General Manager, M.E. and E.E. degrees. Broad management background; training in modern management techniques, heavy machinery and steel mill operating experience; sales and marketing; manufacturing and engineering. Location unimportant for right opportunity. M-577.

Mining Engineer (field or mill work, M.S. in mining engineering. Two years in mineral research of southern college; two years in gold and coal mine. Location open. M-578.

Geologist-Petrographer, M.S. degree from eastern university. Two years experience as petrographer. Interested in employment in petrography and mineralogy. M-579.

Mining Engineer, B.S. degree, age 31. Three years experience as mine foreman; two years mine surveying and mine development planning; an accumulation of college summers spent as miner, motorman, cage tender, etc.; one-year period as practical miner. Presently employed, available April. Location unimportant. M-580.

Junior Geologist, B.S. in geology, Syracuse. Recently completed tour of duty as an Air Force officer. One month field mapping in Wind River Mts., Wyo.; academic laboratory work in mineralogy and petrography. Location immaterial. M-581.

Engineer, B.S. C.E., 1951. Nine years diversified background: pipelining and termineling, seismology, surveying and general construction, project engineering, liaison, supervisory experience. Certified EIT. Prefer East. M-582.

Manager or Vice President in Charge of Mining, B.S. in mining and metallurgy. More than 20 years as manager or in managerial position in a variety of mines. Desire location where good schooling is available. M-583.

EXTRACTIVE METALLURGIST

Research and Development

We are looking for an extractive metallurgist with training in mineral beneficiation. Advanced degree (M.S.) and/or experience in this field desirable but not necessary. Work assignments will involve mineral beneficiation in addition to some inorganic chemical processing.

Address resume including salary requirements to:

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POSITIONS OPEN

Mining Engineers, a) *Mill Superintendent,* graduate mining, with total of 12 to 15 years underground mining and milling experience. **b)** *Mine Engineer* with 2 to 5 years experience. Duties will include underground surveying, ore reserve, and cost studies. Eastern U.S. W9634.

Flotation Engineers, a) *Engineer-Mill Superintendent,* experienced flotation expert, who understands art of processing pegmatite ores by means of flotation reagents. One hundred tons of pegmatite ore per 24-hr day mill, 7 days per week. **b)** *Assistant Mill Superintendent.* **c)** *Foreman.* Personnel should be experienced in pegmatite flotation mill processing. Midwest. W9610.

Mining Engineer with about 10 years experience, to plan underground development and take care of engineering required in such an endeavor. Open pit mine; however, will go underground in the near future. About $8000. Arkansas. W9605.

Plant Superintendent, 30 to 40, for large crushed stone and bituminous concrete manufacturing company. Engineering background desired. Salary commensurate with experience; excellent employe benefits provided by company. Some travel. Pennsylvania. W9561.

BOOKS

McGraw-Hill Encyclopedia of Science and Technology edited by William H. Crouse *et al., McGraw-Hill Book Co. Inc.,* 15 vols., $175, 1960—The more than 6 million words and approximately 10,000 illustrations, drawings, charts, and tables in this unique set of 15 volumes are grouped under some 7200 subject headings to bring together closely related subject matter. There are numerous cross references to related sections. A detailed subject index of more than 100,000 entries occupies 434 pages of Vol. 15. The final volume also identifies members of the Editorial Advisory Board, the 63 consulting editors, and the 2100 contributors who wrote material for the volumes.

All fields of science and technology

(Continued on page 4)

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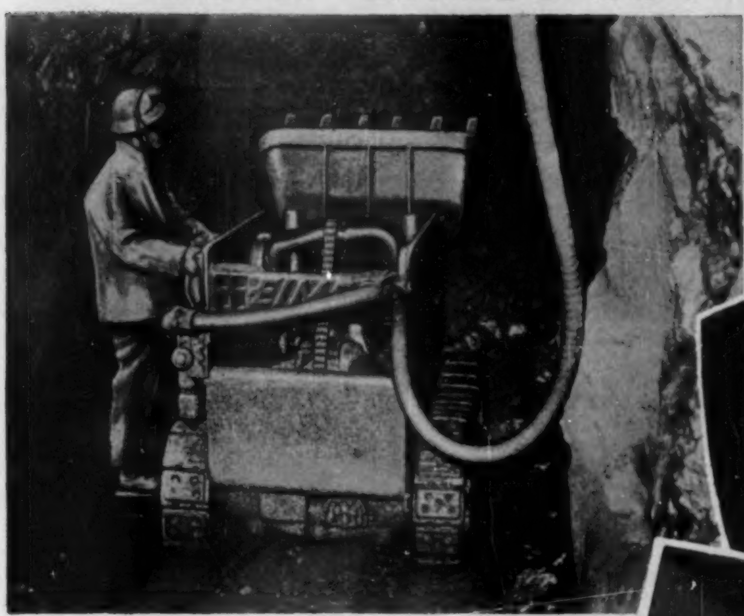
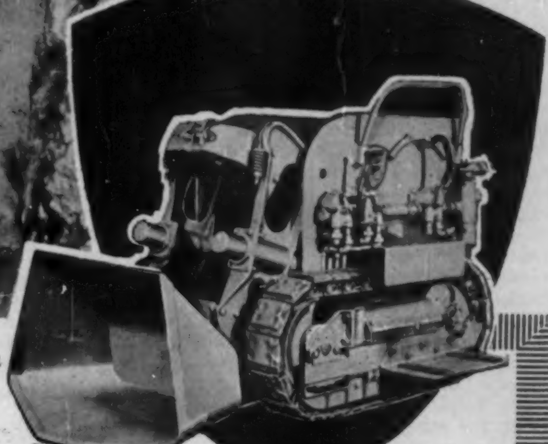


Photograph – Courtesy of Maritime Mining Corporation



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Mineral Information

An International Directory of Engineering Source Material

BOOKS

(Continued from page 2)

Order directly from the publisher all books listed below except those marked • • • The books so marked (• • •) can be purchased through AIME, usually at a discount. Address Irene K. Sharp, AIME Book Dept., 29 W. 39 St., New York 18, N. Y.

are covered on a level generally suitable for college undergraduates, for the serious-minded layman, and for some high school students especially interested in science and technology. It is not likely to help appreciably any engineer or scientist in his special field, but it should often be useful to him as a ready reference source of information in other fields with which he is less familiar. All sciences—life, physical, and earth sciences—are covered, as are major technological and engineering applications in the basic engineering fields. Bibliographical references are given for many subjects. • • •

Handbook of Chemistry and Physics, 42nd Edition, *The Chemical Rubber Co., Publications Div.*, approx. 3500 pp. $12, 1960—This volume, which consists of five indexed sections integrating the latest information in physics, chemistry, heat and hygrometry, mathematics, and quantities and units, provides professional engineers and scientists with a handy reference source in solving problems in the fields of chemistry, physics, and mathematics. Among the subjects revised or added to this year's volume are: analytical reagents, nuclear spins, diffusion of metals into metals, surface tension of inorganic and organic solutes in water, and properties of refractory materials. • • •

Theorie der Schüttgutbewegung by Rudolf Kvapil, *VEB Verlag Technik*, Berlin, Germany, 83 pp., approx. $2.15 (DM 9.00). 1959—Based on a series of laboratory experiments in Czechoslovakia, this small book discusses the laws of motion of both fine and coarse bulk material in bunkers and silos. The observations include symmetric and asymmetric bunkers; bunkers with one and with several borrow areas; split bunkers; silos and grain elevators. The study aims to show that this basic experimental work has finally led to definitions and conclusions which will allow satisfactory bunker construction in the future. The appendix includes a list of German and English references.

Symposium on Air Pollution Control, ASTM Special Technical Publication No. 281, *American Society of Testing Materials*, 1916 Race St., Philadelphia 3, Pa., 44 pp., $1.50, 1960—This volume contains the papers presented at the Third Pacific Area National Meeting of the ASTM in San Francisco, October 1959. The subjects covered are: air pollution potential of California coastal climate; wind and weather summaries for chemical plant design and air pollution control; fluorescent dyes as airborne tracer materials; colorimetric determination of formaldehyde and methanol from combustion sources; and determination of gaseous and particulate inorganic fluorides in the atmosphere. • • •

Analog Computation in Engineering Design by A. E. Rogers and T. W. Connolly, *McGraw-Hill Book Co. Inc.*, 450 pp., $16, 1960—Emphasizing application rather than design and operation, this book demonstrates the use of the general-purpose analog computer in solving industrial problems. A brief introduction describes the principles, capabilities, and limitations of the computer. There follows a concise review of pertinent topics from engineering mathematics, and a full treatment of computer methods of solution. The final section is an analysis of real problems taken from industry, illustrating efficient problem preparation and computer solution. • • •

Air Pollution Manual, Part 1: Evaluation, *American Industrial Hygiene Assn.*, 1425 Prevost, Detroit, Mich., 194 pp., $8.50, 1960—This book, prepared by a group of engineers, chemists, toxicologists, physicists, meteorologists, and others specializing in the field of industrial hygiene and air pollution, provides necessary information for intelligent appraisal of air pollution problems. It includes discussions of the methods, techniques, and instrumentation relevant to investigations of each problem, and a source list of reference literature. Vol. 2, to follow, will deal with air pollution control. • • •

Gold and Money Session, 1960 Pacific Northwest Metals and Minerals Conference, now available. This 60-page booklet includes introductory notes, the three papers presented at the morning session, the luncheon address, and a full transcript of the statements, discussion, and summary by members of the afternoon panel. Subjects covered during the morning session were: "Review of Gold Production," "Gold in the International Monetary System Today," and "The Problem of Gold Convertibility." The subject of the luncheon address was "How to Obtain a Sound International Monetary System."

In summation, perhaps the most important fact to emerge was that any action concerning the production or price of gold should be taken not from the standpoint of the gold mining industry but with regard to the country as a whole and the role of gold in financing international trade. The booklet may be ordered from:

Dept. of Geology and Mineral Industries, State Office Bldg., Portland, Ore.

Make checks, for $1.50, payable to: 1960 Pacific Northwest Metals and Minerals Conference.

Canada

Government Publications

Queen's Printer
Ottawa, Ontario

Report of Royal Commission on Coal, Cat. No. Z101959/2, $2, 1960.
Rare Earths of the Grenville Sub-Province, Ontario and Quebec, Paper 59-10, 25¢, 1960.
On the Uranium Possibilities of the Southern Interior Plains of Canada, Paper 59-16, 25¢, 1960.
The Chemistry of Manganese Deposits, Research Report R8, 25¢, 1959.
The Alum-Amine Process for the Recovery of Alumina from Shale, Research Report R45, 25¢, 1959.
Radiochemical Evaluation of Fire Assay Method for Determination of Silver, Research Report R51, 25¢, 1959.

(Continued on page 18)

Cross section of average extension steel, showing distorted center hole.

Cross section of Sandvik Coromant Steel, showing perfectly uniform center hole.

See for yourself why SANDVIK *Coromant* *Steels* *last longer on the job!*

Sandvik-originated smooth rope-threads make uncoupling easy.

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The completely unretouched photographs above show clearly why Sandvik Coromant large-diameter extension rods last longer! Since Sandvik takes the time—and the trouble—to cold-roll these alloy drill rods, the flushing hole is uniform all the way through—smooth as a gun barrel. And, since the hole is even and perfectly round, you set up fewer strains and stresses **in use**... there's less whipping... and therefore, less breakage. And, with mechanically stronger rods, we can provide larger flushing holes for faster, more complete removal of cuttings.

What's more, the Sandvik-originated rope-thread makes coupling and uncoupling a hand operation—speeds the job—and reduces chance of incipient cracks developing from wrench marks.

All in all, you can't beat Sandvik Coromant Rope-Thread Steels for fast work and long life! Available from 1½" to 2" in diameter. To set up a test on **your** job, write to your nearest Atlas Copco office today. Address: Dept. ME-17.

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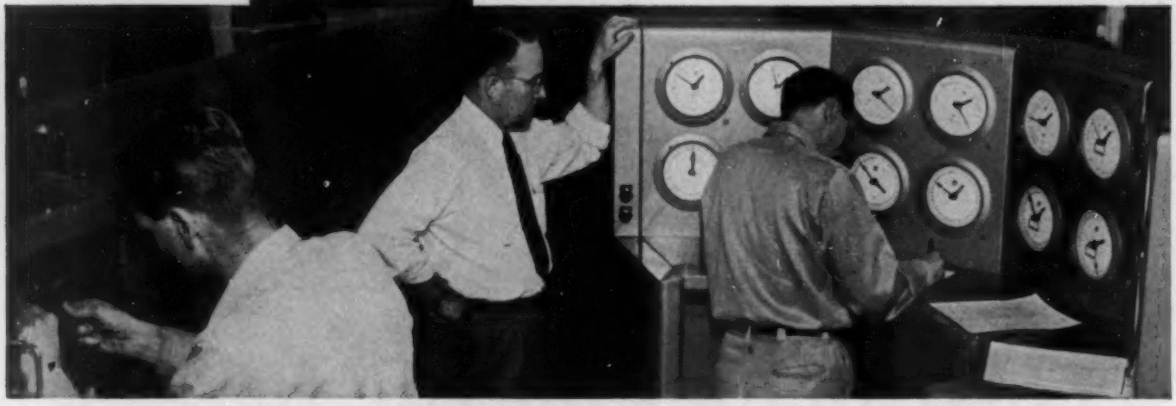

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MANUFACTURERS NEWS

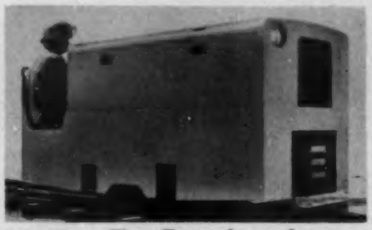
NEWS / EQUIPMENT / CATALOGS

Electric Shovel

Model 270-B electric shovel, recently announced by *Bucyrus-Erie Co.*, is designed to accommodate booms up to 100-ft length and dipper capacities from 8 to 18 cu yd. The machine features a new crawler mounting; a one-piece boom with wide boom foot; new components such as snubber-equipped saddle block, screw-type crowd rope take-up, electric dipper trip; and a variable voltage static control system employing magnetic amplifiers with no moving parts. **Circle No. 1.**

Diesel Mine Locomotives

A new series of diesel mine locomotives with capacities from 2½ to 25 tons has been developed by the *Greensburg Div.* of *National Mine Service Co.* Simple three-lever controls negates the need for a skilled



operator. The Greensburg locomotives can be reversed while in motion without injury to transmission or other equipment, and the units have an exhaust gas conditioner which allows operation underground without hazard of objectionable smoke or fumes from diesel exhaust. **Circle No. 2.**

Air Line Oilers

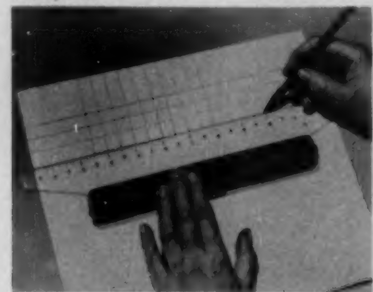
Gardner-Denver Co. has introduced two models of air line oilers for heavy duty field service. Models LO-30 and LO-50, with three and five-gal capacities respectively, are designed for use with heavy equipment such as large drills, jumbos, and large rigs. Their wide range of air capacity reportedly allows them to be used with one or more drills. **Circle No. 3.**

Multiple Use Payloader Bucket

Drott "4-in-1" buckets, designed for the Payloader tractor-shovels, are now available from *The Frank G. Hough Co.* With either 4-cu yd or 1-cu yd capacities, the buckets allow the Payloader to do normal excavating and loading, bulldozing, clamshell pick-up, as well as scraping and grading. **Circle No. 4.**

Calibrated Drawing Ruler

Rol-Ruler Co. is now marketing a handy 12-in. combination triangle, T-square, and parallel ruler. Built-in rollers permit smooth, easy movement when drawing parallel lines or circles. Horizontal and angular lines are automatically measured to as close as 1/16 in. Price: $3.95. Order **direct** from Rol-Ruler Co., Riegelsville, Pa.

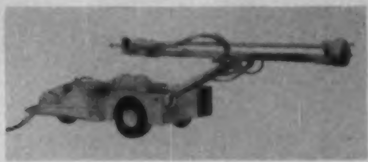


Mobile Belt Loader

Western Conveyor Co. has developed a high-tonnage mobile conveyor belt loader capable of transferring 3500 tph of material into hauling units. The machine features a 60-in continuous running belt which eliminates shear and starting load, and an internal hydraulically-operated gate control and feeder to prevent spilling. A fifth wheel pin, located under the discharge end, permits hook-up and movement by truck. The unit is reported capable of being set up for operation by a two-man crew in two hours. **Circle No. 5.**

Mobile Coal Driller

The TDF-10 Mobile Coal Drilling Machine from *Long-Airdox Co.* has been developed for effective use in coal seams as thin as 28 in. Designed for one-man operation, the unit applies thrust to the auger within 12 in. of the working face, eliminating the problems encountered when drilling



thrust is applied at the auger shank. The unit can drill holes 2½ in. from and parallel to the roof, and requires only 12 to 15 sec to bore holes 9 ft deep. The machine has variable drilling speeds, an auger feed rate to 33 fpm, and a tramming speed to 150 fpm. **Circle No. 6.**

Sludge Pump

A lightweight sludge pump designed to handle liquids containing up to 15 pct solids has been developed by *Chicago Pneumatic Tool Co.* Termed the "CP-71", the unit can eject 40 gpm at a 200 ft head and 100 gpm at 50 ft head. Operating on the ejector

principle, the CP-71 handles rock drill cuttings, sand, or other solids without causing rapid wear of expensive internal parts. The pump has no diaphragms, stuffing boxes, rotors, impellers or pistons to maintain. It is designed to be used with or without a suction hose, and it operates on an 85 cfm compressor. **Circle No. 7.**

THE CALUMET DIVISION* STORY

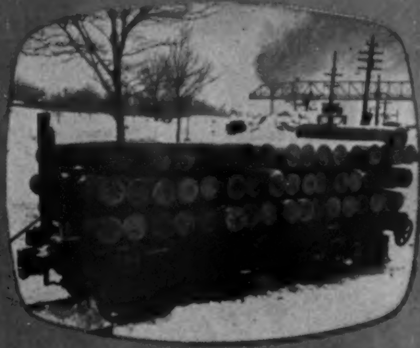
METALWORKING, AGRICULTURE, MINING

*DIVISION OF CALUMET & HECLA, INC.

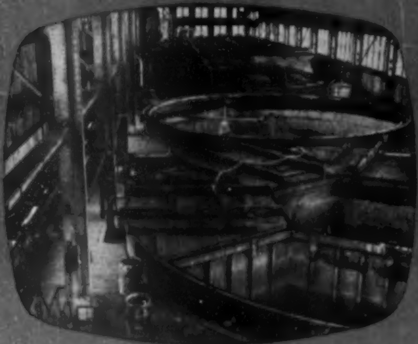
1. One of the many Calumet Division mines from which copper is taken from the earth.

2. Miners many, many feet under the ground, drilling prior to blasting loose chunks of copper ore.

3. The ball mill installation at Calumet grinding the ore before refining. Calumet manufactures Ni-Hard† grinding balls and mill liners for its own use and for sale.



4. Copper billets before shipment. Most billets are sold to the sister division—Wolverine Tube.



5. Copper scrap is reclaimed in giant leaching tanks like this huge battery.

6. Brown copper oxide is marketed for agriculture: a fertilizer grade, a nutritional and fungicidal spray, and a trace mineral feed supplement for animals.

7. Calumet Ni-Hard grinding balls are available from stock in the following sizes: ⅜", ¾", ⅞", 1", 1¼", 1½" and 2".

8. The Calumet foundry also produces giant castings. Ni-Hard mill liners are an important product—not only for Calumet operations, but for the entire mining industry.

9. The Calumet machine and plate shop works not only as a captive plant, but also does custom work for general industry.

10. The uranium mine in New Mexico—another Calumet Division activity.

†Reg. U.S. Pat. Off., Intl. Nickel Co., Inc.

Write for more information on Ni-Hard grinding balls and mill liners.

CALUMET DIVISION

Calumet & Hecla, Inc.

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FREE LITERATURE

(21) EQUIPMENT CATALOG: An 18-page booklet from *The Eimco Corp.* describes and illustrates most of the company's major products presently available. Equipment includes tractors, loaders, mining equipment, and process and filter equipment, plus some of the products of the firm's foundry division.

(22) CRUSHER: Bulletin 17B9746, published recently by *Allis-Chalmers Mfg. Co.*, describes the 16-50 Superior secondary crusher. Designed to handle total output of a 42x54-in. single toggle or a 42x48-in. A-1 jaw crusher, the 16-50 features a 16-in. feed opening, 50-in. diam crushing cone, Hydroset control for instantaneous vertical shaft adjustment, and choice of three eccentric throws for accurate product control. Dimensions and approximate capacities of the crusher is also provided.

(23) DRILL BIT CATALOG: *Kennametal Inc.* has issued an excellent 24-page catalog (No. M-10) listing this company's bits available for metallic, non-metallic, and coal mining. Items cited include cutter bits, rotary drill bits, roof bits, core bits, open pit bits, and augers. Each bit is pictured and described in the accompanying text and specification tables.

(24) A-C LOAD CENTERS: An informative two-page leaflet (GEA-7306) issued by *General Electric Co.* discusses applications, construction, and operation features of its a-c mine load center designed for underground mining operations. These units have recommended ratings of 45 to 600 kva with a primary voltage of 2400, 4160, or 7200 v.

(25) CRAWLERS: "Modern, Profitable Mining Methods with the Eimco 630 Crawler Series" is the title of bulletin L-1057 from *The Eimco Corp.* This 14-page, illustrated booklet includes a short outline of the development of these crawler-mounted air or a-c electric powered machines for mining, shaft-mucking, and loading. Adaptability of the various units is shown by illustrations of various attachments that can be mounted. Also included are a listing of accessories and specifications.

(26) MINING EQUIPMENT CATALOG: *Machinery Center's* latest contribution to the files of Americana combines the poetic biography of Uno the Terrible Finn ("of shaft-sinking fame") with photographs and brief descriptions of

equipment available from the company. Items cited (other than Uno) include safety skip, jumbos, slusher train, folding timber cage, and the Cryderman shaft-mucker.

(27) HANDBOOK FOR CRUSHING: *Nordberg Mfg. Co.* recently issued a 21-page handbook called "How To Get the Most from Your Symons Cone Crusher" which was prepared to aid users of Symons Cone Crushers in securing the best possible performance from the crusher. The handbook discusses some of the common problems and faults encountered in crusher operation. Both bad and good crushing practices are outlined with the help of installation photographs. Nordberg's replacement parts service, factory overhaul, and engineering service are discussed also.

(28) AIR LINE OILERS: A comprehensive bulletin released by *Gardner-Denver Co.* describes their available air line oiler models and discusses the case and operation of pipe lines, hoses, and lubrication for rock drills. This graphically illustrated brochure (No. LD-2) gives operational and specification data on oilers of one half pint to five-gal capacities and cites the advantages of line oilers in providing dependable and uniform lubrication to all working parts of air-operated equipment.

(29) YIELDABLE ARCHES: A well illustrated, 12-page booklet describing the principle of yieldable arches for underground support has been published by *Commercial Shearing & Stamping Co.* The catalog (No. 300-C3) gives complete technical information on segment and connection details, typical arch shapes, accessory details, dimensions, and physical properties of Commercial lagging used in conjunction with the arches. Also shown are 12 case history photographs of typical applications of yieldable arches.

(30) EYE AND FACE PROTECTION: A completely new selection of eye and face protection for a wide variety of industrial applications is described in a 40-page catalog from *Mine Safety Appliances Co.* Highlighted in catalog No. 0300-1 is the "Sightgard" line of eyewear which

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1

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provides maximum protection. Also reviewed in the catalog are vision testing equipment, goggles, face-shields, and welding helmets.

(31) VIBRATORY SCREENING CENTRIFUGE: *WEMCO* division of *Western Machinery Co.,* has released a four-page bulletin describing the new WEMCO-Siebtechnik Vibratory Screening Centrifuge. Operating characteristics of the machine are thoroughly explained and component parts are shown in an enlarged cut-away view. Also included in bulletin D1-B1 is a table of typical performance data.

(32) LEAD ORE PULP DENSITY CONTROL: An illustrated process application sheet which describes the operation of a Bailey lead ore pulp density control system for obtaining more uniform operation and more uniform particle sizing has been issued by *Bailey Meter Co.* Two recorder charts included in the sheet show the difference in operation between manual control and automatic control. The bulletin, No. Q12-2, includes a simplified diagram of a pulp density control system to illustrate the operation.

(33) LEVEL DETECTION SYSTEM: Simplification of control of uranium ore processing through the use of capacitance-level systems, is described in bulletin L-104, published by the *Aeronautical and Instrument Div.* The illustrated brochure describes the installation of the "Level-Tek" capacitance-actuated liquid level detection system at the Homestake Sapin Partners uranium oxide recovery mill near Grants, N. M. The method of detecting levels in a number of locations at the mill, as well as the operation of the all-electronic Level-Tek system in general, is fully outlined.

(34) CAST-TOOTH SPROCKETS: Twelve-page book No. 2867 from *Link-Belt Co.* lists stock sizes of cast-tooth sprockets available for immediate delivery in every major industrial area. Selection data is based on sprocket-to-chain relationship with 132 different chain numbers listed and cross-referenced to 48 sprocket lists. Basic types of sprockets illustrated include arm center, plate center, segmental and split rim sprockets, and traction wheels.

(35) TRACTOR-SCRAPER: *LeTourneau-Westinghouse Co.* has published a 16-page, multi-colored bulletin describing its 20 cu yd (heaped) capacity Model C Speed-pull. Illustrations and text give a full description of the six-wheel tractor-scraper combination and points out many of the machine's features designed for long-haul earth-moving.

(36) LAB TESTING UNIT: Bulletin L1-B4, recently issued by the *WEMCO* division of *Western Machinery Co.,* describes and illustrates the "Mineral Master", a multiple purpose laboratory machine for flotation, agitation, and attrition batch testing. Among its new features, the unit has an adjustable rotor-stator, three alternate drives, adjustable platform, and a safety catch and position collar.

(37) SPECTROPHOTOMETER ACCESSORIES: A 16-page illustrated bulletin, No. 738, has been issued by the *Scientific and Process Instruments Div.* of *Beckman Instruments Inc.,* describing accessories which have been precision engineered to adapt DK Spectrophotometers to the requirements of such analyses as flame photometry, fluorometry, solid phase studies, reaction rate studies, and turbidity observations. Specification tables, detection limit tables, litsing of special features, and ordering information are included.

(38) POWER DISTRIBUTION SYSTEMS: *General Electric Co.* has recently published "Better Power for Production", a 48-page booklet which outlines principles of planning industrial power distribution systems for safety, reliability, and economy while retaining flexibility and provisions for future expansion. Bulletin GEA-7139 includes chapters on choosing voltages, short circuit calculations, protective relaying, selection of unit substations, power factor corrections, and grounding.

(39) NUCLEAR PROBES: *Soiltest Inc.* has issued a six-page illustrated leaflet to introduce two nuclear instruments designed for convenience, speed, and accuracy in measuring moisture content and density of earth materials. The booklet describes the company's complete d/M-Gauge System including Model NU-3 Surface Moisture Probe and NU-2 Surface Density Probe. Specifications for all of the components are included.

(40) HOISTS: A comprehensive, eight-page brochure describing its complete line of hoists has been published by *Coffing Hoist Div.,* Duff-Norton Co. Catalog 600 contains complete specification tables for all Coffing models in lever, power (electric and air), and hand-chain basic industrial hoists. Also included in the two-color booklet are specification tables for hoist accessories and *I*-beam trolley attachments.

(41) AUTOMATIC BLADE CONTROL: Preco "Dial-A-Slope" automatic blade control for *LW* motor graders is the subject of a four-page folder issued recently by *LeTourneau-Westinghouse Co.* The bulletin describes the many functional advantages this transistorized unit reportedly adds to the capabilities of normal grader operation. Illustrations point out design features, installation, and the electric package which is the nerve-center of blade control.

(42) EQUIPMENT BULLETIN: *Le Roi Div., Westinghouse Air Brake Co.,* has expanded its popular bulletin "Products for the Construction Industry" to 12 pages with new product information for the mining, construction, and quarrying markets. Bulletin CG-15 includes information on the Trac-Newmatic, a self-propelled blasthole drill, as well as specifications for stationary compressors. Dust collectors, line oilers, and other air tools are also described.

(43) JAW CRUSHER: Bulletin No. J-14, describing the 14x24 jaw crusher, has been released by *Gruendler Crusher & Pulverizer Co.* Specification charts of overall dimensions, and shaft and bearings, as well as cross-section diagrams of the crusher are included.

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Claim Large Molybdenum Discovery

Molybdenum Corp. of America announced discovery of a large molybdenum deposit in north central New Mexico. Located near the town of Questa, in Taos County, the deposit involves some 260 million tons of indicated ore with a 5-pound-per-ton content of molybdenum disulfide, or the equivalent of 760 million pounds of refined metal. Exploratory work, which started in 1954, was financially aided in the past three years by funds from the Defense Minerals Exploration Administration. No plans for mining will be made until exploration work is completed. **See Page 14 for further details.**

Freeport Sulphur Opens New Mine

Freeport Sulphur Co. put in operation a new sulfur mine at Lake Pelto, some sixty miles southwest of New Orleans on the marshland shore of the Gulf of Mexico. Mining is being done from a barge-mounted plant, used originally a few miles to the north at the now depleted Bay Ste. Elaine deposit.

Inco to Expand Copper Cliff Iron Plant

International Nickel Co. of Canada Ltd. has scheduled an estimated $50 million expansion program slated to triple capacity of its iron ore recovery plant at Copper Cliff, Ont. The plant will treat 1.2 million tons per year of nickel-bearing pyrrhotite high in iron content. According to the company, the process involves solid state pyrometallurgical operations, and the removal of nickel by atmospheric pressure leaching in new high capacity units of company design. The expanded plant is scheduled to be in full operation in 1963. Inco said diversion of this large quantity of pyrrhotite to the new plant will effect a 40-pct decrease in the tonnage of material which would otherwise have to be handled by the nickel section of the Copper Cliff smelter.

Udall Named Secretary of Interior

Stewart L. Udall, Representative from Arizona, was named Secretary of Interior to the new administration, to replace incumbent Fred A. Seaton. Representative Udall, has been a member of the Mines and Mining Subcommittee of the House Committee on Interior and Insular affairs during his tenure in Congress.

Find Metal Deposit Below Barite

Canada's leading barite producer, Magnet Cove Barium Corp., has discovered a large lead-silver orebody beneath its big barite deposit at Walton, Nova Scotia. Some 450,000 tons of the metal ore, which grades better than $32 a ton, has been indicated down to the 850-ft level. A 125-tpd concentrator is planned for working the deposit, and should be completed in October 1961.

(Continued on page 16)

MINING engineering REPORTER

OLD DISTRICT - NEW DEPOSIT

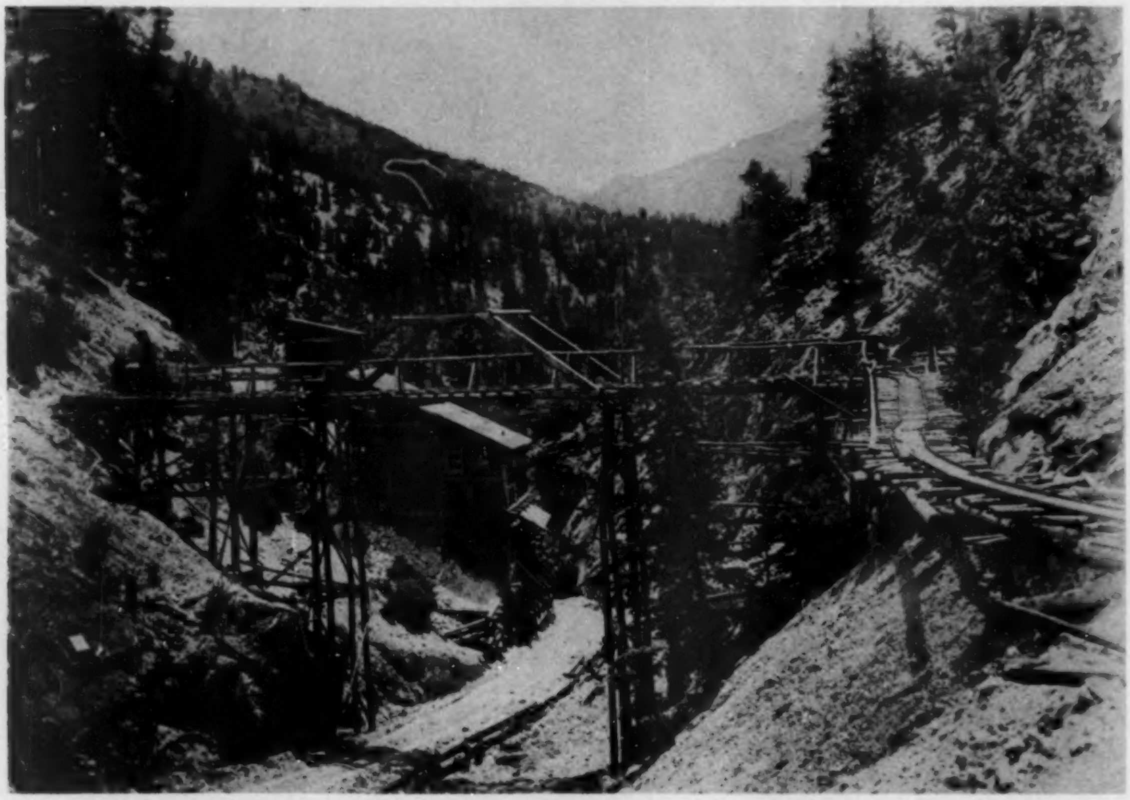
MCA Exploration Finds Large Molybdenite Prospect

New Mexico may contain a molybdenite deposit second only to that at Climax, Colo., according to a recent announcement by the Molybdenum Corporation of America. The new molybdenum prospect, approximately one mile west of the old Questa mine, comprises two separate, but nearby orebodies at depths exceeding 1500 ft. The importance of this deposit to MCA is underscored by the fact that, since the original Questa mine terminated operations in 1956, the company has had to rely on other producers of molybdenum to supply their manufacturing facilities at York and Washington, Pa. and Cleveland, Ohio.

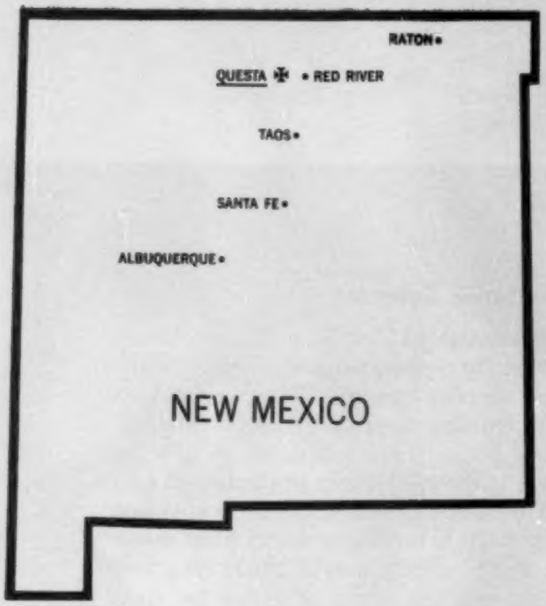
As is true for much of the West, gold was the substance which first drew miners to this area of the Sangre de Cristo Mountains in the 1880's. In 1923, MCA purchased the Questa property and during the next 33 years, the company extracted 20 million lb of molybdenite from scattered high-grade veins which assayed from 3 to 8 pct MoS_2. After 1945, the high-grade veins encountered became fewer in number and in 1956, all mining was terminated at this site.

Exploration Progress: Initial exploration commenced in 1954 at Questa, two years prior to the cessation of the earlier mining operations. From June 15, 1957 to June 30, 1960, exploration work was conducted with the financial assistance of the Defense Minerals Exploration Administration (DMEA), now known as the Office of Mineral Exploration (OME).

The 1954 exploration program was aimed at locating extensions of the ore deposit then being tapped by the Questa mine. Molybdenite-bearing



The Questa mine as it appeared in 1925 when it was one of the largest producers of molybdenum in the world.



fractures found in granite gave rise to hopes of further mineralization occurring somewhere in the area. Since 1956, MCA has been doing underground drifting and diamond drilling in conjunction with some surface drilling. To date approximately 16,000 ft of tunneling has been done, and about 30,000 ft of drill core cut. Accompanying geological and geochemical work directed the exploration toward those areas now being extensively investigated.

Geology and Mineralization: Questa is underlain by early Tertiary volcanics ranging from andesites to welded rhyolitic tuffs. This volcanic series was intruded during the late Tertiary by granite porphyries, porphyritic aplites, and rhyolite porphyries. The geology of the area was recently described by Dr. Robert H. Carpenter at the 1960 International Geologic Conference in Copenhagen, Denmark.*

The molybdenite occurs principally in small veinlets within well-developed vein systems varying in width from several inches to more than a foot. The mineral is also found along fault planes within the country rock. It is thought that the introduction of the molybdenite and associated pyrite occurred after the reopening of small fractures within the host rocks.

Ore Reserves: As of June 1960, ore reserves calculated from drift and drill samples indicated 260 million tons of ore assaying 0.25 pct MoS_2, equivalent to about 760 million lb of contained molybdenum. During the last six months, however, additional exploratory work has extended the boundaries of the two orebodies and disclosed substantial zones of higher mineral content, both within and outside the area explored under the DMEA contract. Evaluation of these new findings indicate that the orebodies will attain or exceed an average molybdenite content of 0.5 pct.

MCA has announced their plans of continuing their program of drilling and tunneling to further define the two enriched zones, but no decision regarding possible mining operations will be made until the further exploratory work is completed.

* R. H. Carpenter: Hydrothermal Alteration and Mineralization at Questa, N. M. *Proceedings of the International Geologic Congress*, 1960, Section 18.

A. L. Greslin (left), Questa manager, and J. B. Carman, MCA mining engineer, examining ore from the new prospect.

(Continued from page 13)

Kaiser, Consolidated Zinc Plan Aluminum Complex

Kaiser Aluminum & Chemical Corp., and Consolidated Zinc Corp. Ltd. announced plans to establish a new aluminum complex in Australia and New Zealand. The agreement involves developing large bauxite reserves and hydroelectric power in construction of the largest integrated aluminum facilities in the southern hemisphere. By mid-1966, the following projects are scheduled to be completed: 1) Development of bauxite reserves in the Weipa area on Cape York peninsula, Australia. 2) Construction of a 360,000 long ton alumina refinery at Weipa. 3) Expansion of the Bell Bay, Tasmania, aluminum reduction works from annual primary capacity of 12,000 long tons annually to a minimum of 28,000 long tons. 4) Development of a hydroelectric source using the water of Lakes Te Anua and Manapouri in New Zealand. 5) Construction of a new aluminum reduction works at Bluff, New Zealand, with capacity of 120,000 long tons of primary metal yearly. 6) Establishment of fabricating facilities. During 1961 Kaiser will invest more than $10 million for developing and expanding the properties, which are presently held by Consolidated, and later will participate equally with Consolidated in construction of additional facilities.

Zinc, Copper Strikes Settled

A new wage pact ended the six-week-old strike at the Anaconda Co. Chuquicamata mine in Chile. An upstep in fringe benefits and a 25-pct increase in wages were included in terms of the settlement . . . . New Jersey Zinc Co. and United Steel Workers have come to agreement on a strike which had lasted since August 5. In new wage contracts that run until July 27, 1963, workers at two smelters and five mines will receive immediate wage increases of from 7½ or 8¢ an hour with an additional increase of 2½ to 5½¢ an hour on March 26, 1962.

Beryllium Notes

A third U. S. beryllium producer has entered the market. The organization is General Astrometals Corp., which will produce and sell beryllium products under licenses from French firm, Pechiney. Production is scheduled to begin in early 1961, with ore received from France . . . . U. S. Beryllium Corp. reports new beryllium deposits are being worked in the old Redskin mine in Park County, Colo., some two and a half miles from the Boomer mine—biggest U. S. producer.

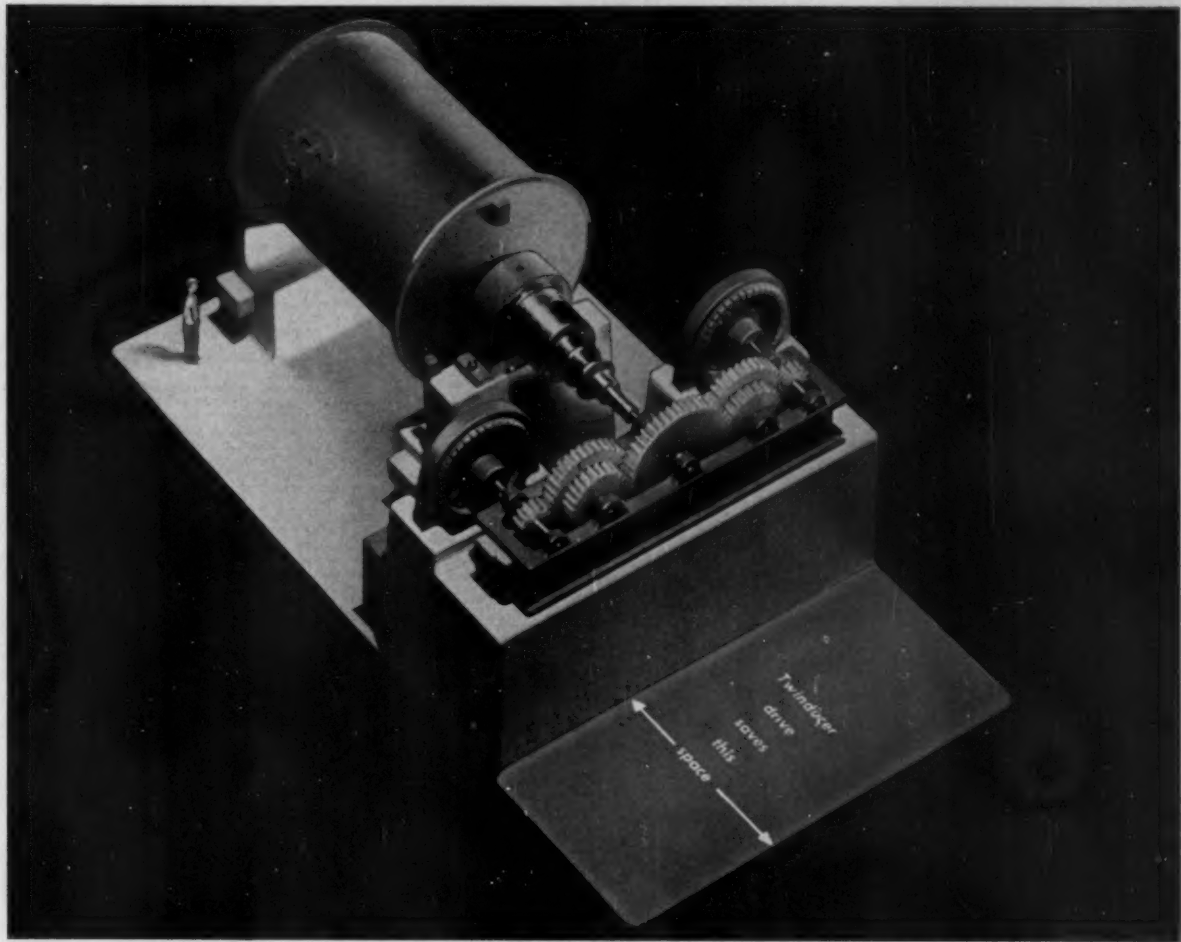
Gold Dredge Begins Bolivia Operation

A subsidiary of South American Gold & Platinum Co. has started operating a gold dredge on the Kaka River in Bolivia. The dredge, expected to produce some 6000 oz of gold monthly, was bought in New Guinea, dismantled, and the parts flown to Bolivia for reassembly and use by South American Placers Inc.

Synthetic Quartz Crystals in Production

The first commercial mass production of synthetic quartz crystals has begun in the Merrimac Valley, Mass., works of Western Electric Co.

ALLIS-CHALMERS



A 2000-hp Twinducer drive mill conserves up to 16 feet of space compared to other trunnion drive designs.

Twinducer drive saves on space and wear...

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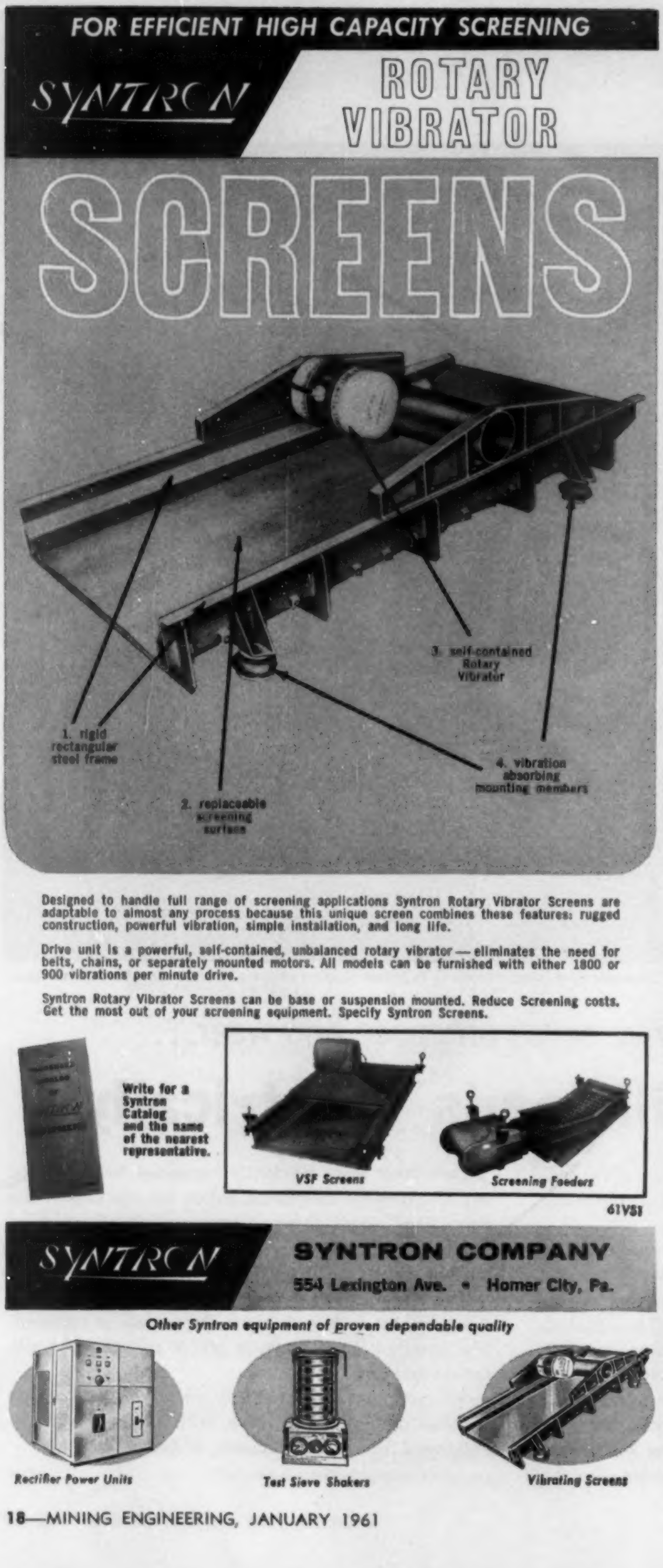

BOOKS

(Continued from page 4)

The Occurrence of Native Nickel-Iron in the Serpentine Rock of the Eastern Townships of Quebec Province, Research Report R57, 25¢, 1959.
Exchange Reactions between Zinc and Its Ions, Research Report R58, 25¢, 1959.
Surface Area Determination of Magnesium Powders by Sorption of C-14-Labeled Oleic Acid, Research Report R60, 25¢, 1960.
Surface Exchange Reactions of Silver and Its Ions, Research Report R62, 25¢, 1960.
Effect of High Temperatures on Concretes Incorporating Different Aggregates, Research Report R64, 25¢, 1960.
A Corrosion Study in Processing Uranium Ore, Research Report R65, 25¢, 1960.
Measurement of Dissolved Air in Alkaline Solutions from Uranium Mills and from Gold Mills, Research Report R71, 25¢, 1960.
Flotation of Uranium Ores from the Elliot Lake Area, Ontario, Technical Bulletin TB2, 25¢, 1959.
Air Oxidation Acid Pressure Leach Investigations of Uranium-Bearing Ores from Elliot Lake, Ontario, Technical Bulletin TB3, 25¢, 1959.
Heavy Media Separation in Aggregate Beneficiation, Technical Bulletin TB5, 25¢, 1959.
The Recovery of Metal Grade Thorium Concentrate from Uranium Plant Ion Exchange Effluents by Amine Solvent Extraction, Technical Bulletin TB13, 25¢, 1960.
Rapid Test Methods for Determination of the Approximate Average Pore Radius, Total Pore Volume and Surface Area Contained in Porous Material, Technical Bulletin TB16, 25¢, 1960.
Measurement of the Wear Rate of Cast Grinding Balls Using Radioactive Tracers, Technical Bulletin TB18, 25¢, 1960.
Technical Advances in Milling and Process Metallurgy in Canada during 1957, Information Circular IC 103, 25¢, 1959.

ABSTRACTS

In This Issue: *The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is given the proper permanent reference to the paper for bibliography purposes.*

Time to Assess Our Future by *Charles Will Wright*—At the present time, the U.S. depends on imports for certain metals in which this country is deficient. The possibility exists that these will not be available from foreign sources at the end of the decade. The author proposes that current events demand an inventory of our present sources of key mineral commodities, obtained now from domestic as well as foreign suppliers. This inventory is needed to provide a realistic future strategic picture, which will assist mine owners in planning long-range development. **Ref.** (MINING ENGINEERING, January 1961) p. 26.

Silverton Project Continues, on Schedule by *Edgar T. Hunter*—About 20 months ago Standard Metals Corp. began extensive development operations at Silverton in the San Juan Mountains in the southwestern part of Colorado. Two mines—once sizeable producers of copper, lead, and zinc—are being reopened, a mill rehabilitated, and a low-level access tunnel constructed. Exploration and further development of one of the mines has been reinitiated. Details of each aspect of the Silverton Project are discussed. **Ref.** (MINING ENGINEERING, January 1961) p. 28.

Combined Geophysical Prospecting System by Helicopter by *Roger H. Pemberton*—The helicopter, outfitted with magnetic, electromagnetic, and radioactivity recording equipment, becomes an advanced and efficient aerial geophysical prospecting tool. A number of the problems encountered—and their solutions—are discussed as well as details of various investigations. Some of the limitations of the

(Continued on page 22)

CYANAMID

Reagent News

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Synergism* Down Under

SODIUM AEROFLOAT® Promoter-Xanthate Combination Increases Copper Recovery at Lake George Mines, New South Wales

Realizing that better metallurgy could come only from more ingenious use of reagents, this well established property centered its laboratory and plant experimental work on new reagent combinations and thereby made very worthwhile gains in recovery.

Lake George Mines has for many years treated upwards of 500 tpd of intimately mixed sulphides in a 40% schistose gangue. Feed from several separate orebodies averages 5.5% Pb; 9.5% Zn; 0.6% Cu; 1.0 dwt Au/ton; 1.3 oz. Ag/ton and 15% Fe. Feed is ground to 77% minus 325 mesh to recover galena, sphalerite, chalcopyrite and iron pyrites in separate concentrates. Copper is floated ahead of lead using starvation quantities of reagent, depressing zinc with SO_2.

SODIUM AEROFLOAT—sodium ethyl xanthate combination was used with good results until import restrictions necessitated replacement of SODIUM AEROFLOAT by xanthate alone from June 1958 to May 1959. Recovery and grade of copper concentrates fell off markedly during this time. Testing done during this period indicated that a combination of SODIUM AEROFLOAT and ethyl xanthate would produce higher recovery than either reagent alone and the combined reagent schedule was adopted again in June 1959. Mill results for two twelve-month periods showed:

	June '58-May '59 Xanthate only	June '59-May '60 SODIUM AEROFLOAT Plus Xanthate
Cu Conc. Grade	17.4%	19.2%
Cu Recovery	74.8%	77.2%

Copper is floated at pH 7 with cresylic acid as frother (0.06 lb/ton) and sulphur dioxide (equal to 1.25 lb. sulphur/ton) to depress zinc. When the promoter was sodium ethyl xanthate alone 0.15 lb. per ton was added. This has been changed to 0.08 lb. of xanthate per ton and 0.04 lb. of SODIUM AEROFLOAT per ton.

Cyanamid field engineers will be glad to work with you to evolve the reagent combination that will produce highest recovery at the lowest cost-plus-tails. Having a complete line of metallurgical reagents, Cyanamid offers unbiased counsel in their most effective use as well as prompt, unfailing delivery to every mining field.

*Synergism—the cooperative action of two discrete agencies such that the total effect is greater than the sum of the two effects taken independently.

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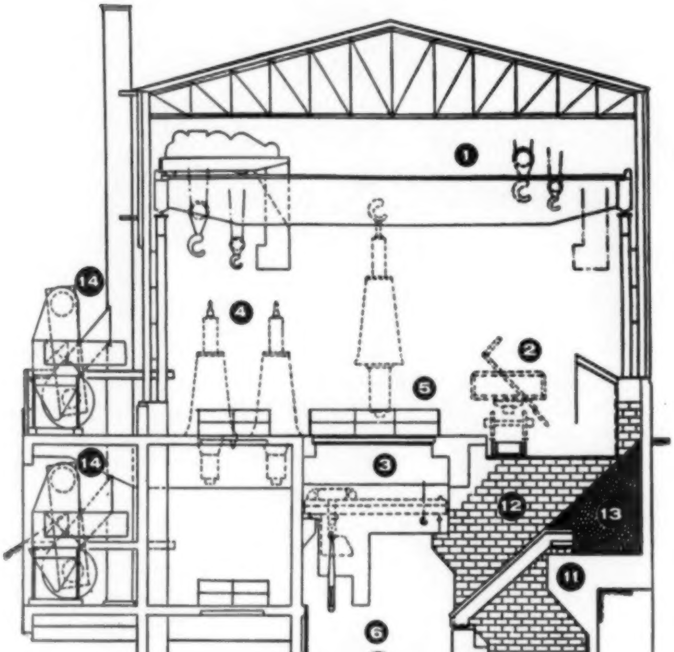

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MINING engineering DRIFT

IDEAS, INERTIA, and ACHIEVEMENT

The current vitality of the Western world's science and technology is sufficient to offset isolated advantages of a government-dominated system, according to a report issued by The American Society of Mechanical Engineers. This report, which presents the views and experiences of chief executives, scientists, and engineers of 88 leading corporations and research institutions in the United States and Western Europe, also offers a set of suggestions to overcome the apparent time lag between original scientific discovery and engineering application in a free enterprise system.

The 100,000 word volume entitled, *Ideas, Inertia, and Achievement* was introduced by ASME President Walker Cisler, Chairman of the Board of the Detroit Edison Co., as a "significant and useful contribution to the efforts of America and the Free World to maintain free enterprise's traditional lead in providing an economic climate in which free men can live better and in greater security than under any other system."

Principal strengths of the Soviet system for speeding practical application of scientific discovery are found to be in: 1) centralized direction of all national research effort, and 2) government-sponsored dissemination of all existing scientific and technical information without regard to competitive conditions or sources.

The American executives, however, find these factors more than balanced by the wide-ranging initiative employed by management in a free-enterprise system, by the additional freedoms enjoyed by both engineers and scientists, and by the much greater experimentation encouraged under private industry.

"Analysis of the Soviet system," according to the report, "shows grievous Soviet errors. Russian management fails to recognize that one mind cannot pre-guess the outcome of scientific venture.

The ASME report does not attempt to gloss over "unhealthy manifestations" in private enterprise. "There was general agreement that the strength of a free enterprise economy stems importantly from a flexible and efficient flow of scientific and technological data. When this flow is impeded, tragic waste results.

It points out that "engineers and technicians, often accustomed to doing a job in a particular way, need to be more alert to the use of improved products and techniques, and less resistant to change." The theme stressed by most respondents is that "The best opportunity for reducing this time lag in individual companies and industries depends not entirely upon the scientists and engineers themselves, in spite of all they obviously can contribute, but upon management's ability to ascertain the significance and importance of original scientific findings—and its willingness to take proper and prompt steps to do something about them."

Two problems were highlighted in the study:

1) The basic scientist does not speak the same language as does the applications engineer. Not only is there need for internal communications within a corporate entity that will assure best possible understanding of the link between discovery and use, but also there must be an awareness of the findings of all other researchers throughout the world in the area of investigation.

2) Adequate or inadequate as the communications system may be, there remains the decision-making function of management as to how and where to spend available capital and manpower, and most importantly, upon how sound a judgment they make as to which of many possible alternate original scientific projects are given first priority.

This volume, made up of individual reports from more than 100 experts of a selected group of industrial and research organizations, was assembled by Fenton B. Turck, president of a consulting engineering firm in New York, and edited by Stanley A. Tucker of ASME. The project was initiated by the Society itself.

Copies of the book may be obtained at $5.00 each from the Order Dept., The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

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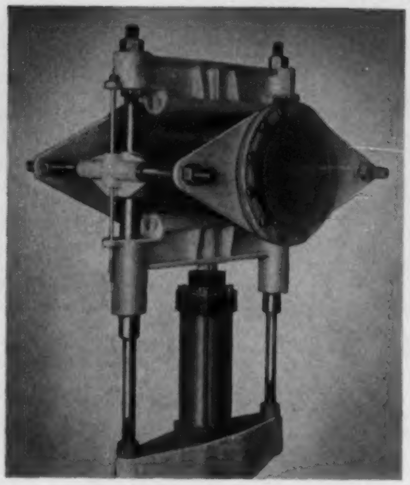

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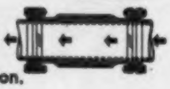

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ABSTRACTS

(Continued from page 18)

equipment are also cited. **Ref.** (MINING ENGINEERING, January 1961) p. 32.

Calculation of Reserves Using a Digital Computer by *Richard F. Hewlett*—A comparison of the polygonal, triangular, and statistical analysis methods of estimating ore reserves was made with the production records from a mined-out portion of the Silver Bell Oxide pit near Tucson, Ariz., utilizing a digital computer for all calculations. Computer programming is described in detail. Actual computing costs and commercial rates are provided. **Ref.** (MINING ENGINEERING, January 1961) p. 37.

Truck Mounted Rotary Drill at Inspiration by *Thomas M. Anderson*—If the mining man cannot find or buy the exact piece of equipment for his particular operation and problems, his motto becomes "design it yourself." Inspiration Consolidated Copper Co.'s open pits lie over old underground workings and drilling and blasting are required for only 50 pct of the material removed. After due consideration of all factors, it was found that a truck-mounted rotary drill best fitted the rather unique requirements of this particular operation. Details of the equipment are given. **Ref.** (MINING ENGINEERING, January 1961) p. 43.

Continuous Filtration of Precipitates by *R. C. Emmett* and *D. A. Dahlstrom*—This paper has reviewed filtration practice as it is used for precipitate dewatering in hydrometallurgy. Its purpose has been to familiarize the engineer engaged in hydrometallurgical process design or development with methods for the successful application of continuous filtration equipment to the filtering and washing of precipitates. The application and advantages and limitations are discussed for the various filters employed in this service. Suggestions are also given to aid in the selection of suitable filter media. Finally, the mechanics of the precipitation step are discussed, with respect to the effects of pressure, temperature, feed recycle, agitation, and introduction of precipitant.

Laboratory test techniques and scale-up methods are mentioned briefly, and references are given for obtaining further information on this subject. **Ref.** (MINING ENGINEERING, January 1961) p. 46.

A Career of Human Significance by *Wayne E. Glenn*—The first years after formal education are critical ones for the young engineer. Some of the immediate problems are discussed in detail: need for continuing growth of technical knowledge, human relations, introduction to the world and language of business and finance, and a role in the community. A pattern is laid for the well rounded career engineer. **Ref.** (MINING ENGINEERING, January 1961) p. 51.

SME Meeting Papers: *The following abstracts of papers presented at SME meetings are given for your information. Copies of these papers are available* **only if followed by a preprint order number.** *These preprints are obtained on a coupon basis. The coupon books may be purchased from SME headquarters for $5.00 a book (10 coupons) for members of AIME or $10.00 a book for nonmembers. Each coupon, properly filled out, entitles the purchaser to one preprint. Mail completed coupons to Preprints, Society of Mining Engineers, 29 W. 39th St., New York 18, N. Y.*

Mechanical Mining in Low Seam Mines by *Clyde H. Storey*—Some of the problems peculiar to the mechanization of very thin seams are discussed, with emphasis on matters pertaining to maintenance and cost control. Increased productivity despite lowering coal heights has been the essence of successful mechanization in thin seams. Without an evolution of face equipment that would allow large quantities of coal to be loaded even though the clearance continues to decrease, there would be no such era of mechanization

(Continued on page 23)

ABSTRACTS (Continued from page 22)

in these pencil mark seams, as the cost of mining would be prohibitive.

Industrial engineering and time study methods have been extensively applied to increase the efficiency of the combined operations which make for a balanced and smooth running operation throughout the complete mining cycle. These methods have been valuable in pointing out bottlenecks and have been helpful in establishing a good distribution of work loads. *ASME-AIME Joint Solid Fuels Conference, Charleston, W. Va., October 1960, 60-F-400.*

Our Knowledge of Underground Gasification in USSR and Comparison with U.S. Processes by *C. D. Pears* and *Milton H. Fies*—Over the past 10 years, Russia has been partially burning coal in place and transporting the resulting combustible gases to nearby locations to be used as an industrial fuel. Considerable information on this work is available from Russian papers and the reports of technical teams that have visited the site. The successful techniques employed by the Russians and a general comparison with work in the U.S. are presented. *ASME-AIME Joint Solid Fuels Conference, Charleston, W. Va., October 1960, 60-F-401.*

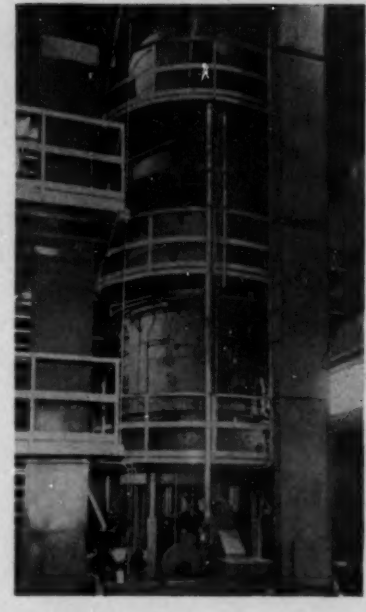
Preprints of the four papers listed below may be ordered from The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y., $1 per copy.

A Decade of Electric Utility Fuel Experience by *Myles E. Robinson* and *William L. Kurtz*—This paper is based largely on a recent study of the postwar fuel consumption experience of electric utilities in the U.S. The data employed are from reports filed with the Federal Power Commission by all but a very small number of the nation's electric power companies. Inclusion of this segment, even if adequate statistics were available, would have little if any effect on the findings established in the study. *ASME-AIME Joint Solid Fuels Conference, Charleston, W. Va., October 1960, 60-FU-1.*

A Concept of Combustion Control for Firing Two Solid Fuels by *Carl E. Rodenburg*—This paper covers a system for controlling the combustion of two solid fuels in a steam-generating unit. In detail, it describes the plan proposed for a boiler installed in the plant of a large eastern manufacturer of bond paper. Coal and bark are the fuels used. Bark flows uncontrolled and the coal flow varies with the change in flow of the steam generated for a selected air flow. Air flow for a given steam output is set manually. In turn the coal flow is set by air flow. The rate of flow of this fuel is stabilized when the desired steaming rate is reached. Undergrate air is measured and a practical minimum is passed through the fuel bed to maintain good combustion characteristics. An oxygen meter monitors the excess air and throttles the over-fire air fan damper. Furnace draft is controlled by regulating the induced-draft-fan inlet dampers. Modifications of the original concept made to meet the owner's requirements are also covered. Design parameters and fundamentals on which the concept is based are detailed. *ASME-AIME Joint Solid Fuels Conference, Charleston, W. Va., October 1960, 60-FU-2.*

The Influence of Volatile Matter on the Combustion of Pulverized Coal by *Joseph F. Mullen* and *Gregory Gould*—The authors indicate an approach and present an hypothesis concerning the influence of volatile matter in the combustion of pulverized coal. In the course of their examination of the subject, the complexity of the combustion problem raises many questions for which answers are essential before a comprehensive understanding of the phenomena involved can be given. The hypothesis presented, although in somewhat simplified form, has helped to explain some of the more common phenomena. The authors conclude that if enough questions are asked and suitable answers developed, the purpose of the paper will have been realized. *ASME-AIME Joint Solid Fuels Conference, Charleston, W. Va., October 1960, 60-FU-3.*

New Concepts—Coal from Mine to Industrial Boilers by *C. E. Day, Jr.*—This paper offers solutions to the problem of reducing investment and operation costs for industrial coal-fired boilers. It calls for concentration on methods already tried and proved effective, but not widely accepted. The paper also discusses briefly some steps that could be taken in the future for more effective use of coal. *ASME-AIME Joint Solid Fuels Conference, Charleston, W. Va., October 1960, 60-FU-4.*



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TIME TO ASSESS OUR FUTURE

by

CHARLES WILL WRIGHT

The author proposes that events demand an inventory of our sources of "key" mineral commodities, here and abroad—to provide a realistic future strategic picture—to assist mine owners at home and abroad in planning future development.

The probability that certain metals in which we are now deficient, may not be available from foreign sources at the end of this decade is a growing danger. At the present time, when countries are nationalizing their industries and, in some cases depriving us of hitherto certain sources, the United States should start planning for its mineral future in order to meet growing industrial requirements.

Russia, Red China, Germany, and Japan have and are carrying out plans to meet their future industrial requirements for metals by intensively developing domestic deposits and increasing their imports. Russia's Seven-Year Plan will not end until 1965, but she is already thinking about a second Seven-Year Plan to end in 1972 by which she hopes to "bury" us. That statement is, of course, more of a myth than a reality for the productive and manufacturing capacities of the Allied nations are several times greater than those of our adversaries. Since such facilities are also expanding each year, there is little to fear at the present time from Khrushchev's threats.

C. W. WRIGHT, Member AIME, was formerly Chief of the Mining Division, U. S. Bureau of Mines, and Chief Foreign Mineral Specialist attached to the Department of State.

We must realize that the Soviet's strength is potentially an incomparable power with its reservoir of vast mineral resources, land, and competent people. It is by deliberate planning that the Russians have achieved their present industrial status, although it has required the sacrifice of human liberties, living standards, and extensive exploitation of labor. We cannot let the USSR and Red China grow stronger while we become weaker due to lack of foresight in securing adequate metal supplies.

THE PRESENT SITUATION

The U. S. now imports more than 90 pct of its nickel, beryllium, columbium, antimony; all of its tin; 85 pct of its manganese, chromite, and bauxite; as well as high percentages of other essential metals. Fortunately, most of our nickel comes from Canada and our antimony from Mexico, not from sources overseas.

We may not have a third World War of the shooting variety, but an aggressive economic trade war

is in progress, and we are in danger of being cut off from sources of metals essential for our industrial progress. These imports could be blocked by communist-led strikes at shipping ports or mines, or by other means of controlling or curtailing output from foreign metal mines. It is imperative that we *secure* these foreign resources for the benefit of the non-communist world—including our friends among the underdeveloped nations.

We have our Office of Civil and Defense Mobilization, which by its stockpiling program is looking after our emergency requirements for strategic metals. Since the stockpiling program is now largely completed, the U. S. has a better degree of protection than at any time in the past. There may be studies in progress by our Executive Branch for our future needs and sources of supply, but no information on this subject is available to the public thus far. (See *U. S. Strategic Materials Stockpiles and National Security* by J. D. Morgan, Jr; MINING ENGINEERING, August 1960).

PLANNING FOR THE FUTURE

To meet our industrial requirements for metals, estimates should be made not only of our needs during the next ten years, but of the probability of securing them now as assured sources of supply. This is essential to our national progress and security.

In 1952 the Paley Commission made a study entitled "Resources for Freedom", which included summaries of the "Outlook for Key Commodities". The presently proposed plan, if carried out, would be confined to a study of the "key" metals, as defined by that report.

Many of our outstanding mining men and Congressional figures are in favor of this plan. Last year Senator Dodd proposed that the President appoint a special committee to study our future mineral needs and update the Paley Commission report. No action was taken on the suggestion.

HOW TO OBTAIN FUTURE ESTIMATES

In view of the dwindling output of most metals from domestic mines, increasing dependence upon imports is inevitable. This is extremely hazardous from the viewpoint of security. It is therefore imperative that we appraise the future with realism. We need to determine our overall requirements for the next decade, and then analyze the quantities of material we may expect from domestic mines and from sources abroad. A long-range estimate of our future requirements and an evaluation of our domestic supply gap would be welcomed by our industrialists, and it would also be helpful to mine owners both at home and abroad in planning their future developments.

Determination of future requirements presents no great problem. Evaluation of future sources of supply is more difficult. Estimates of the output from foreign mines that may be available for export to the U. S. can best be developed by consulting the local Mines Departments in each country. Data obtained from these sources would indicate the possible future tonnages of metal products that may be available for shipment to U. S. consumers.

SAFEGUARDS AGAINST SHORTAGES

As a protective measure and to be prepared for an eventual shortage of manganese, chromium, cobalt, tungsten, mercury, beryllium, and other essential metals, a comprehensive positive program for an intensive development of our low-grade or marginal deposits should be carried out by the U. S. Bureau of Mines. As to greater development of ore deposits abroad, the record shows that practices of stimulating production of minerals for export to the U. S. (as was done during World War II) followed by the imposition of quotas and more protective tariffs, is not reassuring. What foreign metal miners want from us and what we should seek from them are long-term commercial contracts at specific prices. With such assurances, mine owners would be justified in extending development work and improving production methods in order to give the U. S. consumer a guaranteed supply from abroad. It is evident that the present oversupply of copper, lead, and zinc does not call for active development of new deposits of these metals at this time, but we should not lose sight of the fact that these metals could well be in short supply ten years from now.

The Free World nations have vast mineral resources within their borders and if developed by private enterprise the race for metals to maintain industrial superiority will be won.

AVAILABILITY OF FINANCIAL AID

American mining companies interested in new mine development projects abroad have for some years been receiving financial aid for the purchase of mine equipment and other capital expenditures through the Export & Import Bank. They can now obtain loans at low interest rates from the newly formed Inter-American Development Bank and the International Development Association. By taking advantage of such loans, the risk of the American mine investor is reduced, and he is protected against unjust acts by foreign governments which are members of these banks and contribute part of the capital.

The availability of this financial aid should encourage greater cooperation between investors and foreign mine owners, and result in increased mining activities in the less-developed nations. Such joint interests would supply more of the mineral products essential to our industrial welfare.

CONCLUSIONS

The need to start planning for our future requirements of metals and to examine present sources of supply abroad is evident. Such a study will add to our economic and industrial security. But to carry out the plan and maintain our present position of industrial superiority, there must be better cooperation among the Allied nations, which is not always the case. This is most essential if we are to keep the grasping Russians and aggressive Chinese from extending their activities in the mineral fields of the under developed countries of the Free World.

If carried out, the plan will act as a guide for steering some of the development funds now available from the international development banks into mining projects which will help local economy and possibly supply us with some of the metals we need.

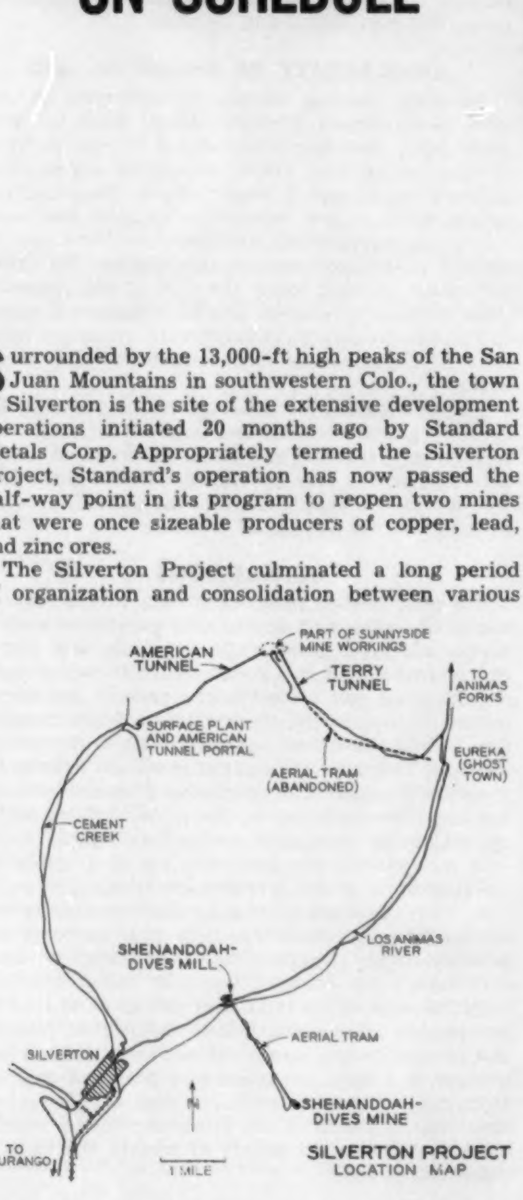
Although the Soviet Union may never catch up with the expanding industrial power of the Allied nations, we must nevertheless realize that freedom and prosperity can be maintained only if the Allied nations as a unit, are alert and prepared to meet disturbing situations with justified counter-measures, one of which is the establishment of definite plans for an assured supply of metals, the basis of industrial power.

SILVERTON PROJECT CONTINUES ON SCHEDULE

by EDGAR T. HUNTER

Surrounded by the 13,000-ft high peaks of the San Juan Mountains in southwestern Colo., the town of Silverton is the site of the extensive development operations initiated 20 months ago by Standard Metals Corp. Appropriately termed the Silverton Project, Standard's operation has now passed the half-way point in its program to reopen two mines that were once sizeable producers of copper, lead, and zinc ores.

The Silverton Project culminated a long period of organization and consolidation between various individuals and companies. Early in 1959, the most recent phase of such consolidations began when Standard Metals Corp. entered into a limited partnership with Marcy-Shenandoah Co. which controlled the assets of the Shenandoah-Dives Mining Co. In December 1959, Standard purchased Marcy-Shenandoah's interest in the partnership and became sole owner and operator of some of the properties of the former partnership and lessee of others.



SILVERTON PROJECT LOCATION MAP

SCOPE OF PROJECT

The Silverton Project has three major objectives:

1) Reopening of the Shenandoah-Dives mine and renewal of an exploration and development plan.
2) Rehabilitation of the Shenandoah-Dives mill.
3) Driving of a low-level access tunnel to reopen the Sunnyside mine now under lease from United States Smelting Refining and Mining Co.

Shenandoah-Dives Mine: The first of these objectives is now substantially completed. Until it was shut down in 1953, this mine was a producer of copper, lead, and zinc ores. The first step in preparation for the resumption of mining operations was the reconditioning of the master raise connecting the main mine level with the upper workings.

Work, originally started under a Defense Minerals Exploration Administration (DMEA) program in 1952, was also resumed to open up the "Letter G" vein of the Silver Lake Unit on the main tunnel level of the Shenandoah-Dives mine. The Silver Lake

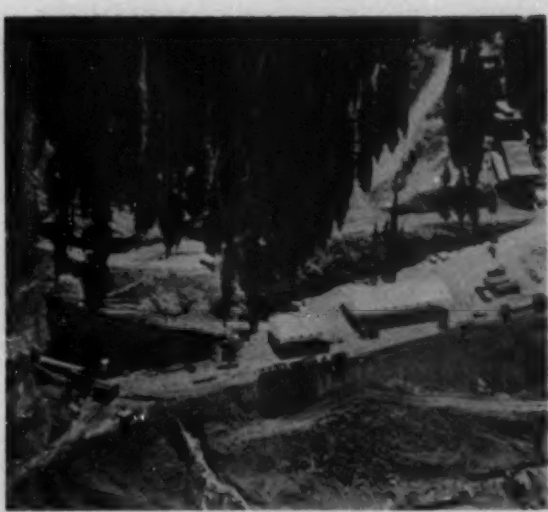
E. T. HUNTER, Member of AIME, is Shift Boss of the American Tunnel Project of Standard Metals Corp., Silverton, Colo.

Unit is a mine owned by American Smelting and Refining Co. but leased to and operated by the Shenandoah-Dives Mining Co. In addition, a 450-ft ventilation and access raise was driven in the footwall of the "Letter G" vein to the lowest previous workings on that vein. This raise was driven with an Alimak Raise Climber, marking its first use in this part of the country. Although initial development goals have been met and work is now being centered around stope preparation, a long-range program to explore for ore at depth has been started.

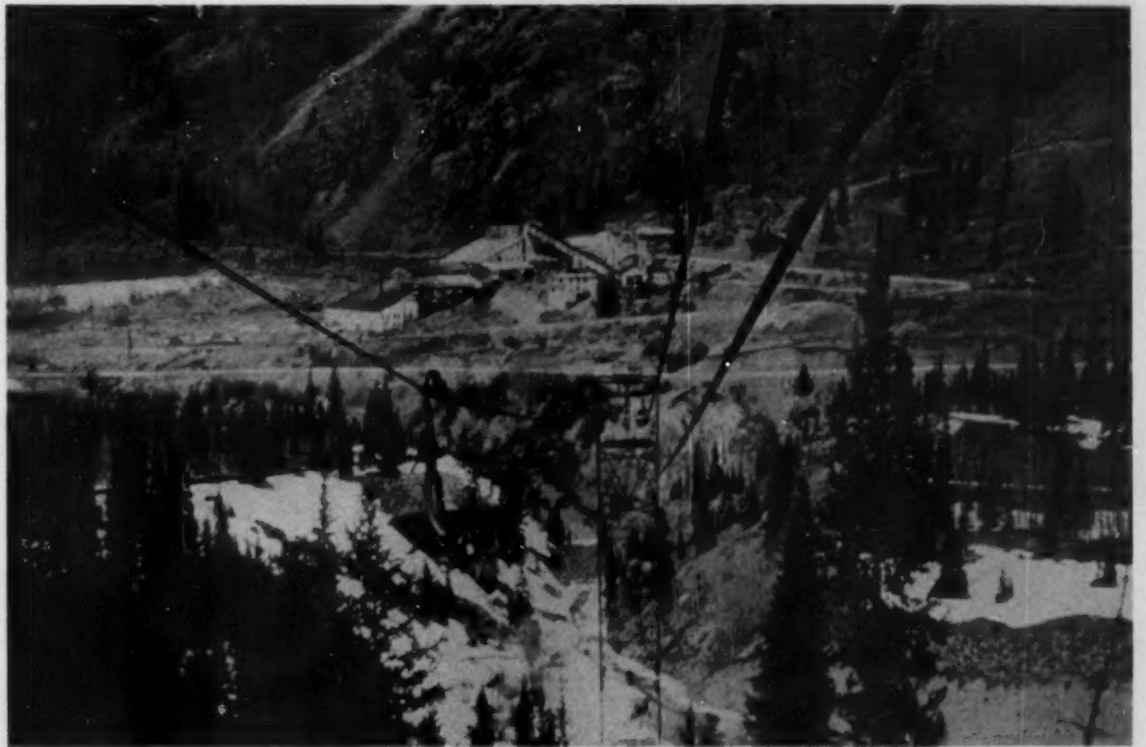
Shenandoah-Dives Mill: This mill, located two miles north of Silverton, is largely rehabilitated and is now operated four days a week. A more efficient crushing and sampling plant has been added to provide better facilities for both custom and company ore. Among other improvements, a new copper circuit was added to the mill to permit better recovery.

In addition to the lead, zinc, and copper concentrates from this mill, a fourth concentrate of manganese will be produced from an experimental circuit to be added to the mill. This project will permit the conversion of the rhodonite gangue mineral which occurs at the Sunnyside mine into a marketable manganese by-product. Research in the past 10 to 15 years by various organizations (including Standard Metals Corp. during the past year) has indicated that this conversion can be accomplished economically under present conditions. Standard is now planning a rather extensive research program of rhodonite conversion so that when appreciable amounts of the mineral become available, all necessary facilities will be available.

Sunnyside Mine: The third principal objective in Standard's development program is the reopening of the Sunnyside mine by enlarging and extending the old American Tunnel. Formerly one of this area's major producers of galena and sphalerite, the Sunnyside originally utilized the Terry Tunnel and a two-mile long aerial tram to transport the ore to the mill at Eureka. This mine was closed in the late 1930's for several reasons, including severe climatic conditions encountered at its 12,000-ft altitude, the long hoists and trams required within the mine, and the increased costs of pumping which were incurred as the mine attained greater depths. When completed, the American Tunnel will overcome some of these problems by providing low-level haulage and drainage.



View of the new surface plant facilities at the entrance to American Tunnel. Tunnel's portal is shown at left.



Aerial tram operates between Shenandoah-Dives mine (elevation: 11,200 ft) and mill (rear), 1600 ft lower. A manganese recovery circuit is planned for the mill in addition to those employed for copper, lead, and zinc.

Interior of the American Tunnel showing tracks, air and water lines (right), power line (left) and ventilation line along back. Some of the 450 ft of steel sets used in the tunnel are shown in rear. View is toward portal.

The drill jumbo, mounted on a converted crawler-loader, is shown making a burn-cut round at the face of the American Tunnel. Each round, loaded with 1¼x16-in. dynamite sticks, is fired with regular gasless delays.

CONSTRUCTION OF THE AMERICAN TUNNEL

The original American Tunnel was driven just after the turn of this century. It served as a low-level access tunnel under the Gold King mine located on the same general vein system as the Sunnyside. Standard's first project was to enlarge the 5500-ft long tunnel from its original 8x10-ft dimensions to an 11-ft width and 12-ft height. Also undertaken at this time was the construction of a surface plant and a new portal to the tunnel. The slabbing of the tunnel, severely hampered by a 900 gpm flow of water originating in the tunnel about 3000 ft from the portal, required about one year for completion.

The second phase now underway is the driving of a full heading, 11x12 ft in section, an additional 5000 ft from the end of the old tunnel. This extension will bring the tunnel under the lowest workings in the Sunnyside mine. At this point a 300-ft raise will be driven from the American Tunnel to the bottom of the old workings for access and drainage. To date, the tunnel has been extended to a point 9768 ft from its portal, leaving approximately 680 ft to go. The tunnel should be completed this month (January 1961) and the raise connection made shortly thereafter.

The tunnel has a 0.5 pct grade which takes it from a 10,589-ft altitude at its portal to about a 10,660-ft altitude below the Sunnyside mine workings. A 36-in. gauge rail track runs the length of the American Tunnel and is flanked on one side by a ditch with a 3-ft width and 2-ft depth. A 24-in. ventilation pipe is attached to the back of the tunnel directly over the tracks. A 6-in. air line and a 2-in. water line are located on one side of the tunnel, and a 440-v power line is strung along the other rib. Communication with the shop and surface plant is maintained through a series of telephones located at various points within the tunnel.

A jumbo mounting three Gardner-Denver D-93's with 12-ft shells and Joy hydraulic jibs is employed to drill the working face of the tunnel. This self-propelled jumbo, made from an old crawler-loader, features an air-powered motor which replaced the original diesel engine of the crawler. In the normal drilling routine, the jumbo is transported by a rail-mounted flatcar to the end of the track located about 20 to 30 ft from the working face. The 6-in. air line is attached to the jumbo's motor by means of a 2-in. bull hose, and the unit is driven to the face where a 32 to 42-hole burn-cut round is drilled and blasted. The ribs and back are outlined on the working face prior to drilling each round by means of candle-type grade-lights.

After blasting the face, an Eimco 630 crawler-type mucker loads the broken rock into the first of five 10-ton Granby-type Card cars operating as a slusher train. This train has a 15-hp electric slusher and a 4-ft wide scraper. The scraper operates on a runway formed by two hard-surfaced rails running the length of each car, and a lip which folds down to connect the cars together. An inverted *U*-shaped boom on the first or bail car holds the slusher pulley block. It has been found that the most versatile and efficient use of these cars is in two 5-car trains rather than one 10-car train. The cars are hauled by two-12 ton diesel locomotives.

Although the ditch is normally carried about 150 ft behind the face, the holes for the ditch are drilled

The Burleigh drill (above) and old timber (below) are some of the relics discovered within the original American Tunnel during Standard Metal's development project.

and blasted with each face round. The ditch is mucked by a two-man crew using a Davis backhoe mounted on a heavy flatcar. The hydraulic pump on the backhoe is driven by an electric motor attached to the 440-v line used to power the slusher unit.

During the face drilling operation, a three-man service crew lays a 15-ft section of track behind the jumbo and/or extends the vent line along the back of the tunnel. A special jib and cradle, designed to hold a 20-ft section of ventilation pipe, is mounted on a flatcar and used to raise both the vent pipe and the 6-in. air line into position hydraulically. The air line and water pipe are extended during the loading phase of the drilling-blasting cycle.

The ground encountered to date stands well and has required only 450 ft of steel sets along its present 9700-ft length. Although daily footage in the American Tunnel is not impressive if compared to the records of high-speed tunnel driving operations, the company feels that the low cost per cu yd of excavated material is due to the high degree of mechanization achieved in driving the tunnel.

Final adjustments are made to the transmitting loop prior to an airborne electromagnetic survey in Canada.

COMBINED GEOPHYSICAL PROSPECTING SYSTEM BY HELICOPTER

by ROGER H. PEMBERTON

The principle of airborne electromagnetic prospecting is well-known. The basic geophysical texts in most cases discuss the main elements involved in electromagnetic prospecting. However, there is certainly little information available to the public concerning the present types of airborne electromagnetic systems being flown today by both contracting companies and some of the mining companies which have their own instruments. This is unfortunate since it is difficult for those people not conducting such operations to understand thoroughly the large variation in the electromagnetic instruments available.

Basically, the aerial electromagnetic induction method utilizes a primary or transmitting coil through which is generated an alternating magnetic field at a frequency generally of the range of 100 to 2000 cycles per sec. This primary field links with buried conductors and generates eddy currents within them. These eddy currents in themselves generate a secondary magnetic field of the same frequency, but generally out-of-phase with respect to the primary field. This secondary field is detected above the ground in the pick-up or receiver coil which is tuned to the frequency of the current applied to the primary transmitter coil.

One of the main problems in the development of an airborne electromagnetic system is that of maintaining constant coupling between the transmitting and receiving coil systems. Any variations in the coupling due to relative motion between the two coils will result in an in-phase signal being induced in the receiver coil. However, any variation in the coupling does not result in an out-of-phase signal change in the receiver coil. The first airborne electromagnetic systems which were developed utilized a large primary coil set up on the aircraft with the receiving coil being towed in a bird, generally at the end of a cable approximately 500 ft in length.

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It is possible with such a system to record the out-of-phase or quadrature responses more readily than the in-phase response. One system utilizes a dual frequency method, whereby the out-of-phase responses at two frequencies are recorded. Another system used today records a single-frequency out-of-phase response. Recently some companies have succeeded in measuring from the air both the out-of-phase and the in-phase components. The usefulness of recording in-phase is well known, but unfortunately this is difficult to obtain in any towed-bird system. In order to measure the true in-phase signal, the most straightforward system is that in which both the transmitter and receiver coils are affixed in space so that there is little or no relative motion between the two coils.

THE FLIGHT SYSTEM

The particular system employed by Canadian Aero Service is mounted on a Sikorsky S-55 helicopter. A record of both the in-phase and out-of-phase responses is made at a frequency of 390 cycles per sec. The transmitter coil is set on a boom mounted in the front of the helicopter; the receiver is set on a tail boom extending back from the helicopter. Separation between these coils is about 65 ft. The two coils are mounted in a vertical co-axial relationship. Having the transmitting coil in a vertical plane ensures that maximum coupling will occur with vertical conductors rather than flat-lying conductors. Having them mounted as they are in a co-axial relationship on the helicopter ensures that maximum response will occur when the flight direction is orthogonal to the strike direction of a given conductor.

The present sensitivity of the EM system is 20 ppm which is certainly equivalent to that of any other airborne EM system being flown today. Depth of penetration is probably in the order of 350 ft from the helicopter. Surveys are conducted at a maximum height of 150 ft, so that penetration beneath the surface of the ground is in the order of 150 to 200 ft.

Auxiliary Instruments: In addition to the recording of the electromagnetic responses, the variation in the total magnetic field intensity is recorded with a Gulf Model III magnetometer, and radioactivity is recorded with a Mount Sopris scintillation counter. The system is therefore capable of recording three types of physical property data, namely the conductive properties, the magnetic properties and the radioactive properties.

DATA CONTROL

In airborne surveying, the general procedure is to fly straight and parallel lines. With the helicopter-borne system, flying is generally done at one-eighth mile spacing. Naturally, it is impossible to keep exact desired flight line throughout the entire course of the survey due to variable winds affecting true ground speed as well as vertical and lateral movements of the helicopter. As the potential fields which are measured are strongly dependent on the distance from source, the true elevation above ground is recorded continually with a radioaltimeter, and the actual flight path is recorded on a continuous strip of film. At the termination of each flight, this film is developed and the actual flight line is determined by identifying corresponding points which occur on the continuous strip film and the photo base maps. Correlation between all the data recorded is obtained by the use of an automatic fiducial counter which at 10-sec intervals marks fiducials on all the tapes and on the film strip.

APPLICATION OF DATA

Electromagnetic: The electromagnetic data are used to locate conductive zones within the earth. Many things are conductive, not all of which are orebodies. Many EM systems are able to locate some conductors and not others, due to the fact that they sample only a limited portion of the full conductivity-size band. By measuring the in-phase and out-of-phase components at the low frequency, it is possible to obtain responses across the whole of the useful conductivity-size band. An estimate can also be obtained of the relative conductivity of different conductors. In some cases within a given locality, it is possible to separate the massive sulfides from the host rock, should the host be conductive, such as is the case for graphitic zones. This only holds, however, if there is a sufficient conductivity contrast between the two rock-types.

Magnetic: Most massive sulfide deposits are both conductive and magnetic. The coincident recording of the magnetic data on the same record as the EM data provides direct correlation between the two sets so that anomalous zones which are both conductive and magnetic can easily and quickly be assessed and picked out. Some of the magnetic responses recorded over massive sulfides have been as low as 20 gammas, even flying at 100 ft above the ground. Such a feature, if recorded even simultaneously but on a different trace than the EM record, would be recognized only by an extremely careful interpretation.

Recording of the variations in the total magnetic field from a helicopter has certain advantages over conventional ground magnetic surveys. These advantages are, firstly that a continuous profile of the magnetic variations is obtained rather than separate spot readings; and secondly, due to the fact that the magnetic measurements are made on a plane removed from the surface of the ground, variations in the magnetic properties of the materials included in the overburden are minimized due to the fall-off in the intensity of the field with distance from the source. The magnetic variations recorded are therefore more probably due to susceptibility changes in the underlying geological formations.

Radioactivity: In some areas the scintillation counter is useful in deciphering the lithology of the underlying formations. This use, however, does not hold for areas covered by thick glacial material and some other types of overburden. It has been found that the radioactive record aids the interpreter in his recognition of many swamps and lakes, many of which are slightly conductive due to the conductive nature of the clays underlying the lakes and many of the swamps. Over such features a marked radioactive low usually occurs, due to the absorption of the gamma radiation by the water or overburden material. Where such radioactive lows occur in conjunction with broad quadrature EM responses, the interpreter can quickly appreciate the flat-lying swamp or lake material as being the cause of the anomalous EM condition. (See Fig. 2 which shows radioactive "lows" coincident with broad out-of-phase response caused by clays underlying shallow lake located just east of the Reed Lake, Manitoba, massive sulfide deposit.)

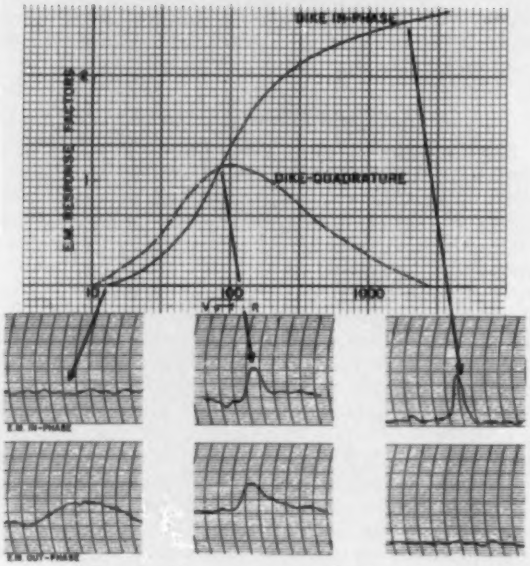

Fig. 1—Response vs conductivity.

PRESENTATION OF GEOPHYSICAL DATA

After the editing and synchronization of the various tapes is accomplished, the Brush tapes upon which are recorded all the geophysical data are handed over to the geophysicist who processes the information. Calculations of the amplitude of both the in-phase and out-of-phase components are made in parts per million. The ratio of the in-phase to the out-of-phase responses is calculated, and the EM information is then corrected for variations in altitude which are recorded on the same tape by a radioaltimeter. This normalization technique expresses the "in-phase" peak response in terms of its percentage of the theoretical response expected over the mid-point of a vertical dike of infinite conductivity from the same altitude. Also provided in a normalization mechanism which compares anomalies in a relative numerical sense, largely eliminating the masking effects ascribed to variations in depth. The "half-peak" width of each in-phase response is then measured and plotted in its correct position along the flight line. This "half-peak" width represents the upper limit of width for narrow dike-like bodies and the actual width for broad ones. Where the magnetic anomaly occurs in direct coincidence with an EM response, note is taken and the magnitude in gammas of such a magnetic anomaly is calculated. This diagnostic information is plotted along with the EM properties at the proper point on the flight line.

In addition to recording the magnetic variations on one of the channels of the Brush recorder with the EM results, the magnetic signal is also recorded on the normal 10-in. rectilinear Gulf recorder. Compilation of the magnetic results into contoured isomagnetic maps is therefore possible. Such a map, when overlaid with the plotted EM results, lends valuable information to the interpretation of the surveyed area.

RESULTS OVER KNOWN CONDUCTORS

Vertical Tabular Structure: Fig. 1 shows in-phase and out-of-phase response curves computed for a vertically dipping dike-like conductor. These responses vary with conductivity, permeability, size of the conductive body and frequency used. It is the first parameter, namely the *conductivity* of the body, about which we are primarily interested in obtaining information.

In order to translate the graphical explanation of these responses to concrete examples of how they appear on the actual recording tapes, three conductors of varying conductivity are shown beneath the graph. The left-hand example is a record of the in-phase and out-of-phase responses obtained over a shallow lake underlain by conductive clay-beds. This lake is located in the Reed Lake Area of Manitoba, and it is to be noted that this conductor is extremely weak, as evidenced by the fact that although there is a broad out-of-phase response, no in-phase anomaly was recorded. Thus the ratio of the in-phase to the out-of-phase response is extremely low.

The middle conductor has approximately a 1:1 ratio and is the response recorded over the Stall Lake massive sulfide deposit presently being developed by Hudson Bay Mining and Smelting Company in Manitoba.

The EM record shown on the right of Fig. 1 was recorded over a barren pyrite-pyrrhotite body located in the Chibougamau area of Quebec. The body here is highly conductive as evidenced by the fact that no out-of-phase response was recorded but a very good in-phase response was obtained. Thus the in-phase to out-of-phase ratio is very high and is explained graphically by a conductor whose conductivity in *mho* per metal would lie to the right-hand side of the graph.

Massive Sulfide Area: The three records shown in Fig. 2 were obtained over a massive sulfide zone located in the Reed Lake area of Central Manitoba. The sulfide zone consists of near massive pyrrhotite and pyrite with scattered specks of chalcopyrite and sphalerite in a silicified and generally chloritized gneiss. The sulfide zone strikes roughly north-south and lies approximately 600 ft west of the western shore of a fairly large shallow fresh-water lake. The three records above were obtained along east-west flight traverses flown at approxiately 330 ft line separation. The record shown on the left-hand portion of Fig. 2 was the northernmost traverse; the others (central record and right-hand record) were obtained along lines flown at 300 ft intervals progressively across the southern striking part of the zone.

These records illustrate four important points:

1) The sulfide zone is an excellent conductor, having an average in-phase to out-of-phase ratio exceeding 3:1. (Note the sulfide zone directly underlies the peak of the large in-phase responses.)

2) The records show that the zone is characterized by only an extremely weak or low magnitude magnetic anomaly. On the northernmost traverse, the magnetic anomaly occurs as only a small inflection on the western limb of a large magnetic "high". Its order of magnitude here is perhaps only 15 gammas (one small division on the record chart). The next two traverses show that the zone is characterized by a separate and coincident magnetic high which is increasing in magnitude from north to south. The obvious conclusion to be drawn is that the pyrrhotite which is known to exist in fairly massive proportions in the sulfide is, however, only weakly magnetic. (This variation in the

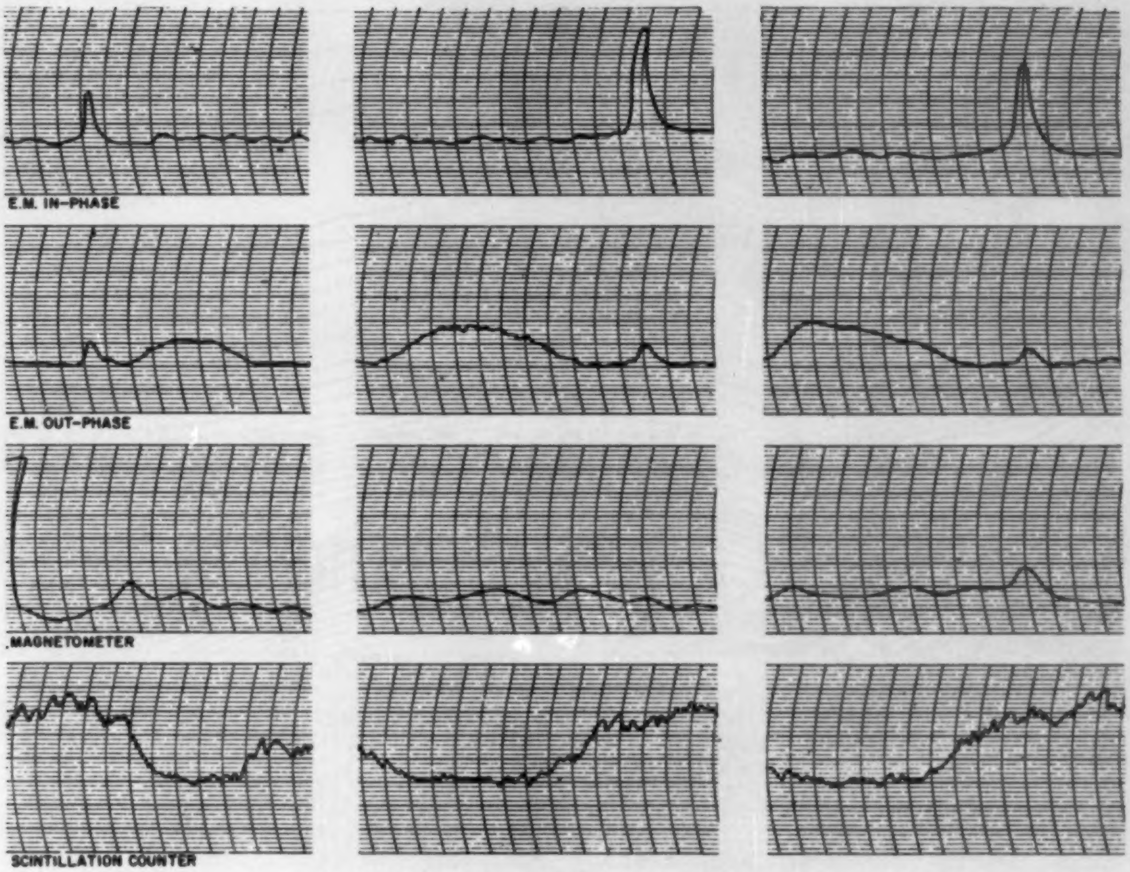

Fig. 2—Reed Lake massive sulfides.

magnetic susceptibility properties of pyrrhotite is generally recognized by most exploration personnel but often is forgotten quickly.)

3) The broad EM response shown on the out-of-phase trace and occurring to the right of the sulfide response on the first record and to the left on the following two, is caused by surface conductors associated with the lake lying about 600 ft east of the sulfide zone. The conductive material in this case is undoubtedly the clay beds underlying the lake surface at a shallow depth. The relative conductivity of these clay beds is extremely low, as evidenced by the fact that no corresponding in-phase response was recorded over the lake.

4) The bottom traces of each of the three records appearing in Fig. 2 are radioactivity measurements obtained with a Mount Sopris (sodium-iodide crystal) scintillation counter. Each trace shows a marked negative depression or decrease in the radio activity directly under the broad out-of-phase response caused by the conductive clays underlying the lakes. This decrease in the radio activity arises due to the fact that the gamma radiation emanating from radio active sources under the lake is completely absorbed by the covering lake water. Thus we see that the radioactivity record is useful in sorting out some of the uneconomically uninteresting EM conductors, such as those caused by surface conductive layers, from those which are of possible economic interest.

Iron Formation: Two isomagnetic maps (Fig. 3) show the airborne magnetic results obtained over the same block of ground at two different altitudes. The survey flown at a mean terrain clearance of 500 ft and at a 1320 ft line spacing was taken directly from the airborne magnetometer maps published by the Geological Survey of Canada. This map shows a large positive 10,000 gamma magnetic "high" striking roughly east-west, which is caused by a large belt of iron formation striking through this part of Quebec. The second isomagnetic map shows the airborne results obtained over the same area but flown at a terrain clearance of 150 ft and at a line spacing of 1000 ft. As would be expected, the low level survey shows both increased resolution of the anomalies recorded and higher magnetic amplitudes. Note how the 10,000 gamma magnetic "high" recorded at 500 ft is resolved into a larger number of separate magnetic features, one of which has a peak value of 17,000 gammas—almost twice the former magnitude.

Of extreme interest is the small but intense magnetic anomaly found in the north-central part of the area by the low-level survey. This anomaly has a peak value of 3500 gammas above about a 2300 gamma background, or a total closure of 1200 gammas. This particular anomaly was completely missed by the first survey. Most probably the original survey lines, flown at a spacing of 1320 ft, straddled the peak of this 1200 gamma anomaly and thus missed much of its anomalous field.

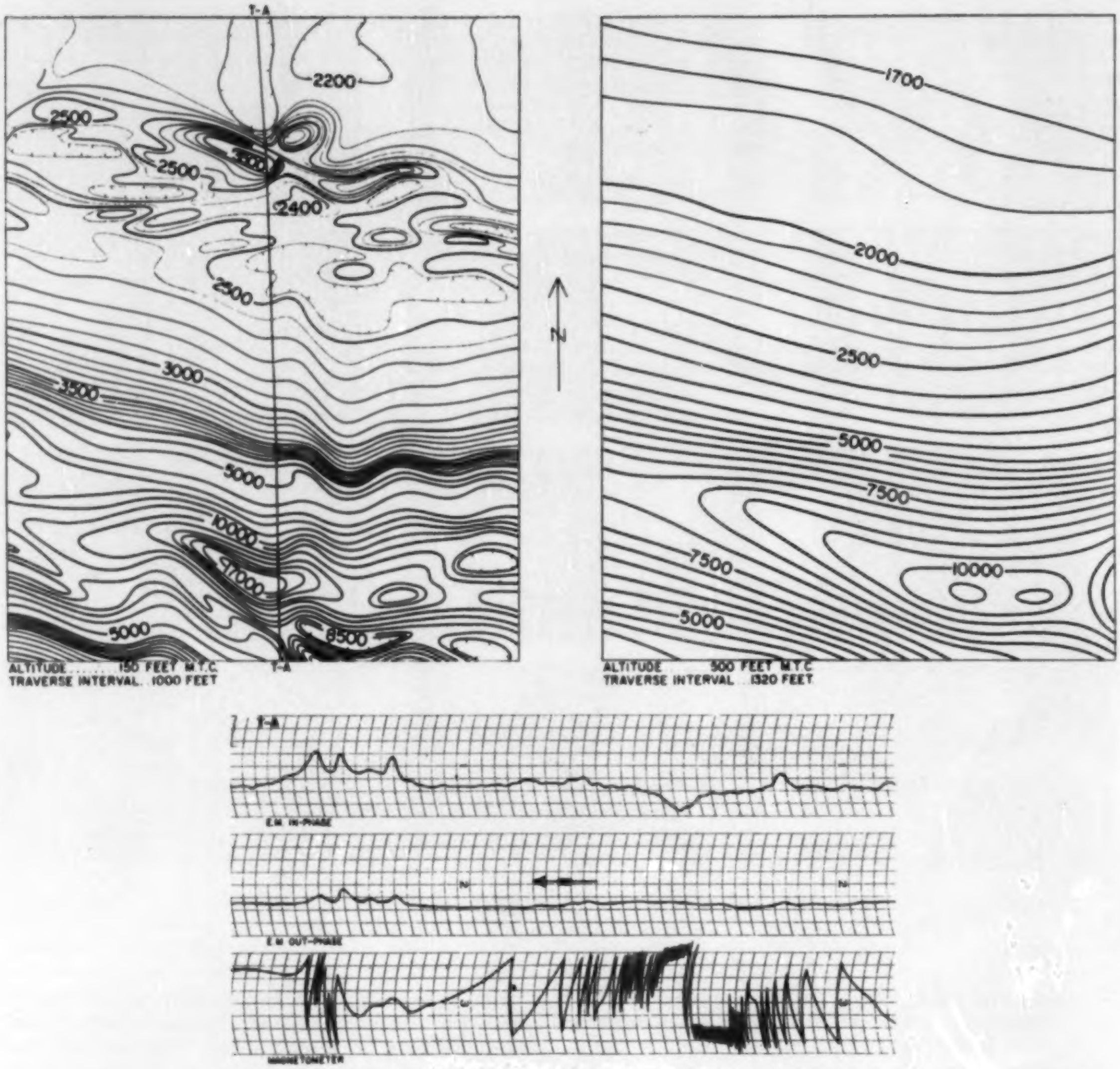

Fig. 3— Magnetic response vs altitude.

SUMMARY

The helicopter, outfitted with magnetic, electromagnetic and radio-activity recording equipment, unmistakably represents a very advanced and efficient aerial geophysical prospecting tool. The designers of this equipment have been successful in overcoming a large number of the problems which were encountered previously in other airborne geophysical surveys. These problems, in the main, have been: 1) the great need to be able to obtain responses across the entire conductivity-size band, 2) the need to have coincident and simultaneous recordings of both the magnetic and electromagnetic responses on the same record, 3) the need for better resolution of the electromagnetic and magnetic results than it has previously been possible to achieve at higher altitudes, and 4) greater control of the positioning of the data so that subsequent ground follow-up work on any of the recorded anomalies would be at a minimum.

In spite of these necessary improvements, a number of limitations to the employment of this system and the interpretation of the recorded data still exist. As with any other type of electromagnetic equipment, the Canadian Aero/Newmont EM system is still only capable of exploring to a finite depth. This maximum depth of exploration figure appears to be about 350 ft sub-helicopter. The electromagnetic system would therefore be incapable of locating buried conductors which do not persist to within 200 to 250 ft of the surface. As such it would not be feasible to employ this method in areas where the depth of oxidation is in excess of this figure. This necessarily rules out many parts of the world, such as most of the southwestern States, many of the Caribbean countries and other places where the original metallic minerals have since been oxidized so that they presently exist in the form of sulfates, oxides, etc.

Even in areas such as the Precambrian Shield of Canada and other Shield areas where oxidation is non-existent or at a minimum, the inherent ambiguities in the interpretation of any geophysical data still exist. It is believed, however, that having available three different types of physical property data (i.e., magnetic, electrical, radioactivity) aids to an appreciable extent in resolving the ambiguities.

The Oxide Pit at Silver Bell.

CALCULATING ORE RESERVES USING A DIGITAL COMPUTER

by RICHARD F. HEWLETT

All ore reserve estimates are based on some system for assigning an area of influence to each drill hole. Commonly used methods of calculation are the polygonal, triangular, statistical analysis, and cross-sectional. Each of these methods is based on different volumetric considerations and the weighting of grade with tonnage varies with each method. Because the characteristics of each mineral deposit are different, a preliminary survey of these characteristics should be made for each individual deposit to determine which method or methods should be used.

In this project the several methods were not only compared with one another, but also against actual production records. Basic data was derived from a mined out portion of the Silver Bell pit near Tucson, Ariz. All calculation was carried out on a digital computer, and the first step was development of computer programs which would yield the desired information. The second step was the coding of input data into punched card form. Cost and speed of computer operation were measured, and these results are given with the computer program summaries on page 38.

Polygonal Method: The assumption is that the area of influence of each drill hole extends half-way to the neighboring drill holes. Thickness and grade must vary uniformly in opposite directions for errors to tend to be compensating. Where the thickness and grade vary in the same direction the errors will accumulate.

Triangular Method: The assumption is that a linear relationship exists between the grade difference and the distance between all drill holes. In deposits with erratic mineralization, this relationship is anything but linear.

Statistical Method: Statistical analysis of drill-hole data to estimate the average grade of a mineral deposit considers only the assay values and not the volumes which they represent. Therefore, no weighting of the assays is made with volume. The only weighting of the assays made by the author was the weighting of each assay value with the respective frequency of occurrence of that assay value for the entire deposit.

Cross-Sectional Method: Assay and other data are projected to predetermined planes and the areas of influence of the assay data are determined mainly by judgment. This method is helpful not only for ore reserve computations, but also for mine planning.

DIGITAL COMPUTER PROGRAMS

Digital computer programs for computing ore reserves, developed by the author, can consider the following computational variables:

1. Type of mine (open pit or underground).
2. Varying tonnage factors.
3. Uneven assay intervals.
4. Numerous grade cut-off points.
5. Different reference elevations; as pit bottoms, ore blocks, and so forth.
6. Different boundary lines for the deposit (property, geological, or proposed pit limits).
7. Irregular areas on mine maps or cross-sections.
8. Various vertical drill-hole and/or deposit intervals.

All costs quoted are commercial rates charged by the Numerical Analysis Laboratory at the University of Arizona or by Western Computing Consultants, both of Tucson, Arizona.

ANALYSIS OF METHODS

Numerous data assembly and computational procedures served as a basis of analysis and comparison for the three ore reserve estimation methods considered in this paper. One is to compute the reserves by the three methods with the data from the total drill-hole depths and compare these results with those obtained by using only the data from the drill-

(Continued on page 39)

R. F. HEWLETT is a Research Fellow, Dept. of Mining & Metallurgy, University of Arizona, Tucson. **This article is based on a paper presented at the Symposium of Surface Mining Practices, October 1960. Proceedings of this Symposium, sponsored by the University of Arizona, will be published by the University.**

Numerical Analysis Laboratory, University of Arizona.

COMPUTER PROGRAM DESCRIPTIONS

POLYGONAL METHOD

Computer input: Drill-hole survey and assay data (vertical drill holes).
Computer output: For each polygon, the following are calculated and printed under an alphabetic title:

1. Drill-hole number of the central drill hole
2. Total polygonal tonnage calculated by two methods
3. Average grade of the polygonal volume
4. Cumulative summation of tonnage
5. Cumulative summation of weighted average grade
6. Tonnage of each grade class (ore, leach, and waste)
7. Cumulative summation of tonnage and average grade for each grade class (ore, leach, and waste).

Data reduction cost (Benson-Lehner Oscar E): $0.25 per polygon; total cost for 127 polygons was $31.87.
Separate program to calculate area of each polygon: $1.75 per 100 polygons; total cost of 127 polygons was $2.22.
Punched-card data assembly cost: $0.047 per polygon; total cost for 127 polygons was $6.00.
Computer computational rate and cost: 8.2 polygons per minute or $0.07 per million tons; total cost for 127 polygons was $26.60.

TRIANGULAR METHOD

Computer input: Drill hole survey and assay data (vertical drill holes).
Computer output: For each triangle the following is calculated and printed under an alphabetic title:

1. Triangle number
2. Total triangle tonnage calculated by three methods
3. Average grade of triangular volume
4. Cumulative summation of tonnage
5. Cumulative summation of weighted average grade
6. Tonnage of grade classes (ore, leach, and waste)
7. Cumulative summation of tonnage and average grade for each grade class (ore, leach, and waste).

Punched-card data assembly cost: $0.10 per triangle; total cost for 250 triangles was $25.00.
Computer computational rate and cost: 4.8 triangles per minute or $2.70 per million tons; total cost for 250 triangles was $72.90.

STATISTICAL ANALYSIS METHOD

Computer input: Any assay values (drill hole, drift, surface, channel, etc.
Computer output: Average grade and number of assays in any predetermined grade class (ore, leach, waste, and total).
Computer computational rate and cost: About $2.00 per 1000 assays; total cost for 3,247 assays was $6.00.

CROSS-SECTIONAL METHOD

Input: Coordinates of points around the areas to be calculated (determined by Benson-Lehner data reduction equipment).
Output: Areas of each irregular surface.
Cost of data reduction: About $0.025 per point.
Cost of computer program: About $0.003 per point.

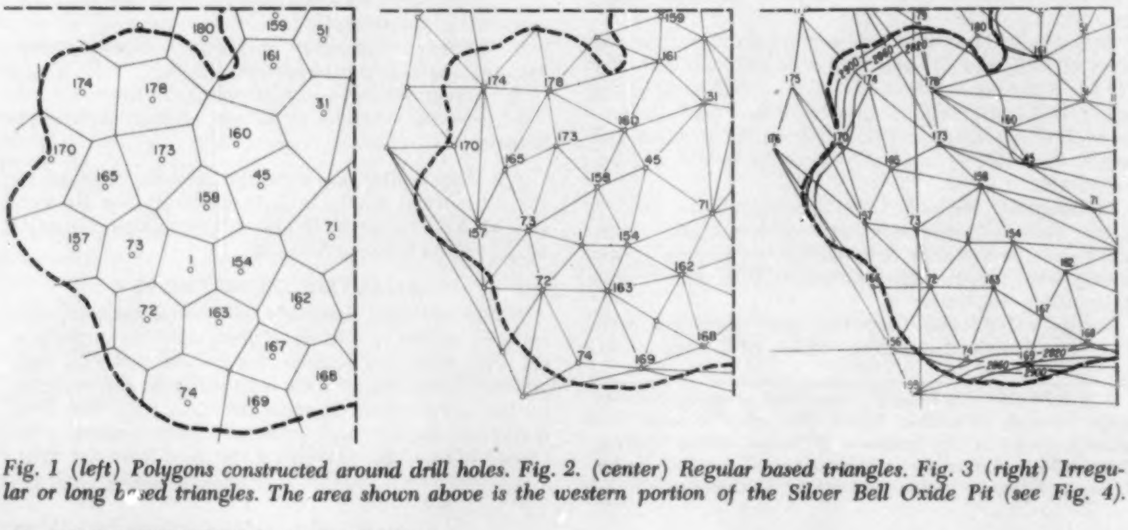

Fig. 1 (left) Polygons constructed around drill holes. Fig. 2. (center) Regular based triangles. Fig. 3 (right) Irregular or long based triangles. The area shown above is the western portion of the Silver Bell Oxide Pit (see Fig. 4).

hole depths inside the pit limits. Different computational procedures are used for each method and the results are compared. Various geometric configurations are also considered. Another important basis of comparison is that of computing the reserves for various vertical intervals within the deposit. This is achieved by having computer programs select only assays within predetermined elevations, such as the top and bottom of a bench.

Polygonal: Drill-hole data was assembled for 1) the entire hole depths and 2) for only the depth of the holes above the pit bottom or pit slope. The tonnage was calculated by two methods; one method involves the difference of elevation and the other uses the total assay interval for the *average depth* of the polygonal prismoid (volume).

Table I shows the results of computing the ore reserves both for the entire drill-hole depth (All) and for the drill-hole data inside the final pit limits (Pit). A 40-ft bench (2820) was divided into various intervals and the ore reserves were calculated for each of the intervals. A comparison of the results showed the effect of various vertical intervals on the ore reserve calculations. Variations will be greatest for discontinuous mineralization.

1. Close agreement exists between the tonnages computed by the two methods.
2. The assay interval method should be used for computations inside the pit limits.
3. The changes in average grade due to weighting with different tonnages was only slight.

Table II shows the tonnage and grade of the classes of material for reserves calculated by 10, 20, and the full 40-ft vertical interval of the bench.

1. The greatest grade and tonnage changes are shown by the ore.
2. Grade and tonnage of waste and leach changed very little.
3. Grade is computed most accurately for the ore using four 10-ft vertical intervals for the 2820 bench.

The effect of the location of the pit slope (limits) on the ore reserve computations was determined by using the total depth of the drill holes (to the 2820 elevation) within the surface pit limits and comparing these results with those obtained by using only the depth of the drill holes inside the pit slope. The intersection of the pit slope and the peripheral drill holes was determined graphically.

Observations made from Table III are:

1. Pit slope affected the grade computation for the waste and leach slightly.
2. Grade of ore in the richest vertical zone or blanket (Bench 2820) was greatly affected by the pit limits.

Triangular: Silver Bell drill-hole data was assembled, both into triangles for the entire drill-hole depths and into triangles for only the depth of the drill holes above the pit bottom and pit slope. Two triangle configurations were drawn using the same drill holes. One configuration was generally regular and the other was irregular and consisted of very long-based triangles.

Observations made from Table IV are:

1. Grade of ore and total material was not

(Continued on page 41)

Fig. 4—The overall pit outline is shown superimposed on the triangle configuration used for comparison of results with polygon configuration shown in Fig. 1 on opposite page. The area reproduced in the first three figures is outlined in the lower left corner of this view.

Table I. Results of Polygonal Method

Method of Calculating Tonnage	Depth of Drill-Hole Assay Used	Class of Material	Grade, Pct of Total Copper	Tonnage, Million
Elevation Difference	All	Waste	0.08	12.05
		Leach	0.30	11.61
		Ore	0.60	14.24
		Total	0.34	37.90
Assay Interval	All	Waste	0.08	11.91
		Leach	0.30	11.66
		Ore	0.60	14.12
		Total	0.34	38.68
Elevation Difference	Pit	Waste	0.07	17.22
		Leach	0.30	12.70
		Ore	0.61	7.98
		Total	0.26	37.90
Assay Interval	Pit	Waste	0.07	11.42
		Leach	0.30	10.03
		Ore	0.61	7.33
		Total	0.29	28.78

Table II. Reserves Computed using Various Intervals, 2820 Bench

Vertical Interval, Ft	Class of Material			
	Waste Tons, Grade*	Leach Tons, Grade*	Ore Tons, Grade*	Total Tons, Grade*
40	4,838,714 0.05	1,499,061 0.32	4,639,420 0.80	10,977,196 0.41
20	4,956,917 0.04	1,671,278 0.29	4,146,602 0.89	10,774,797 0.42
10	5,148,058 0.04	1,720,058 0.30	3,850,702 0.95	10,718,540 0.35

* Grade is reported as pct total copper.

Table III. A Comparison of the Effect of Pit Slope and Vertical Pit Sides

Bench	Class of Material			
	Waste Tonnage, Grade*	Leach Tonnage, Grade*	Ore Tonnage, Grade*	Total Tonnage, Grade*
2860 Pit	4,675,882 0.05	1,002,512 0.26	1,946,518 0.86	7,624,912 0.28
2860 All	4,559,035 0.04	1,581,435 0.29	3,164,167 0.86	9,304,637 0.36
2820 Pit	4,838,714 0.05	1,499,061 0.32	4,639,420 0.80	10,977,196 0.41
2820 All	4,084,848 0.05	2,139,833 0.30	5,152,658 0.93	11,377,340 0.50

* Grade is reported as pct total copper.

Table IV. Comparison of Triangle Configurations

Triangle Configuration	Class of Material	Grade, Pct Total Copper	Tonnage, Million
Regular	Waste	—	12.23
	Leach	—	12.53
	Ore	0.52	12.44
	Total	0.32	37.20
Irregular	Waste	—	11.53
	Leach	—	13.73
	Ore	0.53	12.28
	Total	0.32	37.55

Table V. Comparison of Polygonal Method and Production Records, 2820 Bench

Vertical Interval, Ft	Tonnage Pct, for Classes of Material			
	Waste	Leach	Ore	Total
40	44.06	13.66	42.28	100.00
20	46.00	15.52	38.48	100.00
10	48.03	16.04	35.93	100.00
Average	46.04	15.07	38.89	100.00
Production	30.80	30.29	38.91	100.00
Difference	−15.24	+15.22	0.02	0.00

Table VI. Comparison of Polygonal Method, Statistical Analysis of Blast-Hole Data, and Production Records, 2820 Bench

Method and/or Data Source	Grade Pct, for Classes of Material			
	Waste	Leach	Ore	Total
Polygonal—Exploration Drill-Hole	0.04	0.30	0.95	0.35
Statistical—Blast Hole	—	0.29	0.97	—
Production Records	—	0.39	1.00	—

Table VII. Comparison of Drill-Hole Data and Blast-Hole Data, with Production Records

Source of Assays	Number of Assays	Statistical Average Grade	Actual Grade, Production Records
Exploration drill holes, ore, leach, and waste			
All drill holes Nos. 1-80	1,594	0.35	0.32
All drill holes Nos. 101-180	1,653	0.31	0.32
Pit drill holes Nos. 1-180	2,337	0.30	0.32
All drill holes Nos. 1-180	3,247	0.33	0.32
Exploration drill holes, leach			
Pit drill holes Nos. 1-80	1,240	0.27	0.35
All drill holes Nos. 1-80	1,594	0.27	0.35
Pit drill holes Nos. 101-180	1,097	0.28	0.35
All drill holes Nos. 101-180	1,653	0.29	0.35
Pit drill holes Nos. 1-180	2,337	0.28	0.35
All drill holes Nos. 1-180	3,247	0.29	0.35
Development blast holes, leach			
Bench No. 2860	1,927	0.29	0.36
Bench No. 2820	2,418	0.29	0.38
Exploration drill holes, ore			
Pit drill holes Nos. 1-80	1,240	1.06	0.93
All drill holes Nos. 1-80	1,594	1.07	0.93
Pit drill holes Nos. 101-180	1,097	0.85	0.93
All drill holes Nos. 101-180	1,653	0.85	0.93
Pit drill holes Nos. 1-180	2,337	0.98	0.93
All drill holes Nos. 1-180	3,247	0.96	0.93
Development blast holes, ore			
Bench No. 2860	1,927	0.95	0.95
Bench No. 2820	2,418	0.97	1.00

Table VIII. Comparison of Triangular and Polygonal Methods with Production Records, Tonnage

Computational Method	Class of Material	Grade, Pct Total Copper	Tonnage
Triangular	Waste	—	10,895,826
	Leach	—	9,514,013
	Ore	0.53	4,787,530
	Total	0.28	25,197,367
Polygonal	Waste	0.07	11,421,147
	Leach	0.30	10,027,057
	Ore	0.61	7,333,073
	Total	0.29	28,781,281
Production Records	Waste	—	16,942,700
	Leach	0.35	6,423,820
	Ore	0.92	7,501,100
	Total	—	30,867,620

Table IX. Comparison of Triangular and Polygonal Methods with the Production Records for Percent of Classes of Material

Computational Method	Tonnage Pct for Classes of Material			
	Waste	Leach	Ore	Total
Triangular	43.24	37.76	19.00	100.00
Polygonal	39.68	34.84	25.43	100.00
Average	41.46	36.30	22.24	100.00
Production Records	54.89	20.81	24.30	100.00
Difference	13.43	−15.49	2.06	0.00

Table X. Comparison of Triangular and Polygonal Methods for the 2820 Bench

Computational Method	Class of Material	Grade, Pct Total Copper	Tonnage
Triangular	Waste	—	3,743,270
	Leach	—	1,873,704
	Ore	0.72	3,869,942
	Total	0.42	9,486,916
Polygonal	Waste	0.05	4,838,714
	Leach	0.32	1,499,061
	Ore	0.80	4,639,420
	Total	0.41	10,977,196
Production Records	Waste	—	2,528,170
	Leach	0.38	2,486,790
	Ore	1.00	3,194,500
	Total	—	8,209,460

affected by triangle configuration.

2. Tonnage of the ore was slightly affected by triangle configuration.

3. Tonnage of leach was affected the greatest by triangle configuration.

COMPARISON WITH PRODUCTION RECORDS

Polygonal: Ore reserves computed by the polygonal method were compared with the production records for the 2820 bench. The computations were made for the 40-ft bench using three different vertical intervals.

Observations made from Table V are:

1. The average percent tonnage of waste computed by the polygonal method is overestimated by about the same amount (15 pct) as the tonnage of the leach is underestimated. This is due to the fact that the tonnage of ore was computed very closely.

2. A 20-ft vertical interval estimates the percent tonnage of the classes of material most accurately for the 2820 bench.

Polygonal and Statistical: Grade computed by the polygonal method in four 10-ft vertical intervals and the assays from the 40-ft blast holes for the 2820 bench were compared with the production records from that bench.

Observations made from Table VI are:

1. Grade of the ore is computed more accurately with a larger number of samples.

2. Grade of the ore computed by the polygonal method agrees closely with that computed statistically from the blast-hole data.

3. Grade of the leach was computed consistently low.

Statistical Analysis: Average grade computed statistically for all classes of material using both exploration drill-hole and blast-hole data was compared with the production records. "All" drill holes refer to the drill holes in and around the open pit and "pit" drill holes refer only to those drill holes inside the pit limits and the drill-hole intervals above the pit slope. Drill holes numbering 1-80 were drilled prior to 1948 and those numbering 101-180 were drilled between 1948 and 1952.

Analysis of Table VII shows:

1. The precise location of the pit limits prior to calculating grade (ore reserves) had little effect on the grade computation.

2. The use of all drill holes within the immediate pit area yielded a slightly more accurate estimation of grade.

3. The grade (and consequential tons) of leach indicated by the drill-hole and blast-hole essays is less than that shown by the production records. (The majority of this difference is believed due to the mining method).

4. The grade of the ore calculated from the blast-hole assays agrees closely with the grade shown by the production records for the respective benches.

5. Additional drilling after 1948 did not improve the grade estimate of the leach but greatly improved the accuracy of the grade estimate of the ore.

Triangular and Polygonal: Tonnage and grade were computed by the triangular and polygonal methods using the full drill-hole depths and then using only the length of the drill holes inside the present pit limits.

An analysis of Table VIII shows:

1. The triangular method seriously underestimates the grade and tonnage of the ore using the full drill-hole depth.

2. Tonnage of the ore computed by the polygonal method is very accurate, but the grade is seriously underestimated using the full drill-hole depth.

3. Total tonnage computed by the polygonal method is more accurate than the tonnage computed by the triangular method.

Reported errors in the collar elevations of the drill-holes used for this comparison caused an underestimate of tonnage by about one million tons. A tonnage factor of 12.5 cu ft per ton was used for all material, causing further error in tonnage. In general, the total tonnage computed by the triangular and polygonal methods agree closely with the production records, certainly close enough for preliminary ore reserve estimates.

Table IX compares the triangular and polygonal methods of computing tonnage with the production records as a percentage of total tonnage for each of the classes of material.

Observations made from Table IX are:

1. The polygonal method computed percent tonnage of the ore most accurately and the average percent tonnage of ore agrees closely with the production records.

2. The average percent tonnage of waste computed by the two methods was underestimated by about the same average percent tonnage that the leach was overestimated by using the two methods.

Ore reserves were computed for the 2820 bench by the triangular and polygonal methods.

Comparisons made in Table X show:

1. The triangular method is more accurate than

Oxide Pit at Silver Bell from the air. Mill is directly above pit, and town of Silver Bell is located at upper right.

the polygonal method for computing tonnage of waste, leach, ore, and total material for the 2820 bench.

2. The polygonal method is more accurate for computing the grade of the ore for the 2820 bench on 40-ft vertical intervals.

SUMMARY OF OBSERVATIONS

The previously made observations can be summarized as follows:

1. The triangular method computed the best estimate of total tonnage of leach, percent total tonnage of waste, and tonnage of waste, leach, ore, and total material for the 2820 bench.
2. The polygonal method computed the best estimate of total tonnage of waste, ore, and total material, and the percent total tonnage of leach and ore. This method computed a good estimate of grade for the 2820 bench on 10-foot vertical intervals.
3. The statistical method computed the best estimate of grade for the leach, ore, and total material.
4. The triangular and polygonal methods underestimated the tonnage of the waste by about the same tonnage the leach was overestimated for a portion of the deposit with an average grade of 0.32 pct total Cu. The estimate was completely reversed for the 2820 bench, with an average grade of 0.57 pct total Cu.

CONCLUSIONS

From the foregoing study the following conclusions have been made:

1. The triangular, polygonal, and statistical methods should all be used and a comparison then made the results to determine the ore reserve estimates. Use of the digital computer for ore reserve computations yield more precise and consistent results with a great saving in time and money. Realistic total costs for ore reserve computations using three methods would range from $300 to $3,000. The cost depends mainly on the number of separate computations made with each method for various vertical intervals.
2. Accuracy of the tonnages computed by the polygonal and triangular methods are dependent on the average grade of the material or the grade cutoff points.
3. Precise location of the pit limits is not critical for computing statistically the grade of the waste, leach, and ore. The effect of the pit limits on the ore reserve computations is sufficient to justify computations using different proposed pit limits in order that a better estimate of tonnage and grade is obtained. These preliminary pit limits can then be used as basic information for future mine and mine plant design calculations.
4. Inaccurate estimates of the ore reserves indicate that factors other than the ore reserve computational method, geometric configurations, pit slope and pit limits effect the estimates of grade and tonnage. Some of these factors are mining and milling method, geological and physical characteristics of the deposit, mining equipment combinations, numerous costs and other economic considerations.

Many factors affect such calculations as ore reserves, ore inventories, pit limits, ore recovery, ore control, minimum grade that can be mined at a profit, and bench or pit developments. Because of this, further research should be conducted to better define the effects of these factors on the various calculations. This research will necessitate the use of a digital computer.

TRUCK MOUNTED ROTARY DRILL AT INSPIRATION

based on a report by THOMAS M. ANDERSON

More and more, the spirit of mining men seems to be "If you can't buy what you need, then design it yourself".

From the start of production in 1915 until 1948, underground block caving operations accounted for all of the ore production of Inspiration Consolidated Copper Co. Open pit development work began in 1947, and ore production from the open pit commenced in March 1948. Thus began the transition from underground to open pit mining which continued until August 1954. Since then, open pit mining has accounted for all ore production which presently averages 105,000 tons of ore and 75,000 tons of waste rock each week.

Open pit mining operations at Inspiration is carried on in two separate pits—the Live Oak Pit and the Thornton Pit. The Live Oak Pit covers an area of approximately 1500x3000 ft and the Thornton Pit, 2500x2000 ft. The geographic centers of the two pits are 4000 ft apart and, at their nearest point, the surface slopes are 500 ft apart.

Portions of both pits lie over old underground workings. In these portions, referred to as "undercut areas", most of the ground is so broken that no drilling or blasting is required. During the last five years, it was only necessary to drill and blast approximately 50 pct of the total material removed from these areas.

Both 50-ft and 25-ft bench heights are used but most of the production comes from the higher benches. During the past three years it has been found necessary to use 25-ft bench heights in some undercut areas where ore and waste rock are mixed as a means to facilitate ore-sorting operations. Within the pits, active operating benches vary from 25 to 300 ft apart in elevation with usually one electric shovel assigned to each active bench.

Ore and stripping requirements have made it necessary to mine many of the benches in relatively narrow strips. This and the proximity of the plant to some areas have limited the size of our blasts to an average of five holes per shot, and most of the blasts are in single line patterns.

Prior to November 1955, when our first rotary drill was placed in operation, five 9-in. churn drills were used for blasthole drilling. A total of six churn drill operating shifts were scheduled per day to meet drilling requirements.

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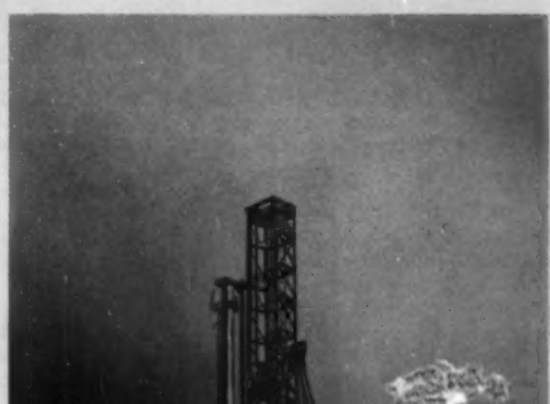


The Reich 9-in. rotary drill at Inspiration.

WHY A TRUCK MOUNTED ROTARY DRILL?

A study of the drilling requirements in the light of Inspirations somewhat unique operation indicated, that if the full potential of a rotary drill could be realized, it would be possible to do all drilling with only one machine. In order to accomplish this, it would be necessary for the machine to be highly

The Thornton Pit as it looks today. Truck in lower center is near site of a "glory hole", now closed for repairs.

mobile and be able to make preparations to move with a minimum of lost time. An indication of the nature of the scattered and varied drilling requirements is apparent in the preceding paragraph. The churn drills were scheduled to operate only 40 pct of the possible operating shifts. The need for five drills arose as our operations began to enlarge in areal extent, but the added inconvenience, lost time, and increased cost of frequent churn drill moves became an operating problem.

At the time the purchase of a rotary drill was first considered, rotary blast hole drilling was relatively new and only a limited variety of drills were available. There were then no 9-in. rotary drills on the market with the mobility that was desired. After much study and deliberation, a truck-mounted drill capable of drilling a 6¼ in. hole was purchased from one manufacturer. This drill had a separate power unit for rotary and compressor drive and a hydraulic controlled mast. A water injection system was installed in our shops for dust control.

A comparison of cost and performance of the 6¼-in. rotary drill and the 9-in. churn drill is shown in Table 1. These figures show that Inspiration enjoyed very little saving in tonnage costs by changing from churn drilling to 6¼-in. rotary drilling, due principally to the fact that to break the same amount of ground, the number of 6¼-in. holes needed was twice the required number of 9 in. holes. A 6¼-in. drillhole has 50 pct the volume of a 9-in. hole and, consequently, the between-hole-spacing was halved.

The first rotary drill, however, had many operational advantages over the old churn drills. Some of these advantages were: the convenience of not having to supply drill sites with power, water, casing, bits, and miscellaneous supplies; the reduction in manpower required for drilling (six churn drill crews replaced by two rotary drill crews); mobility, which made it possible to "knock-down", move from one pit to another, and set-up for drilling in an approximate total time of 30 min. This mobility feature is a very convenient thing to have when digging in undercut ground because a hard toe will occasionally be found in an area where there has been digging without prior blasting. It is then an easy matter to move in, drill the several holes required and move on to another drilling location with a minimum of moving and lost time.

Table I. Comparison of Churn Drill and Rotary Drill Performance and Costs*

	Churn Drill	6¼-in. Rotary	9-in. Rotary
Ft per shift	1	5.70	4.90
Cost per ft	1	0.39	0.50
Cost per ton	1	0.96	0.59

* Using 1955 churn drill performance as Base (1).

Table II. Rotary Drill Operating Performance*

	Ft per Shift	Ft per Bit	Bit Cost per Ft	Tons per Ft of Hole**
6¼-in. Rotary	390	1200	7.8¢	46
9-in. Rotary	343	2350	7.4¢	95

* 1st six mo. 1960.
** 50-ft bench.

After several years experience with the first rotary drill, and pleased with the mobility feature of the truck-mount, the feasibility of mounting a 9-in. rotary drill on an old haulage truck chassis was considered. One KW-Dart haulage truck at the mine was equipped with relatively new oversized rear axle assemblies which made it particularly well suited as a drill carrier.

After conferring with the Reich Drill Co., it was felt that this truck would be a very practical mounting for their Model 750 drill. After determining the necessary specifications, the haulage truck cab and chassis was shipped to their plant in Pennsylvania for the drill installation.

This Reich Model T-750 drill, capable of drilling a 9-in. hole, is equipped with a separate power unit, two 540 cfm compressors, an hydraulic-controlled mast, hydraulic pumps for the rotary drive, pull down and leveling packs, and a hydraulically driven water pump for dust control. The truck and drill weighs 80,000 lb with the weight so distributed that a maximum of 45,000 lb down pressure can be applied to the bit.

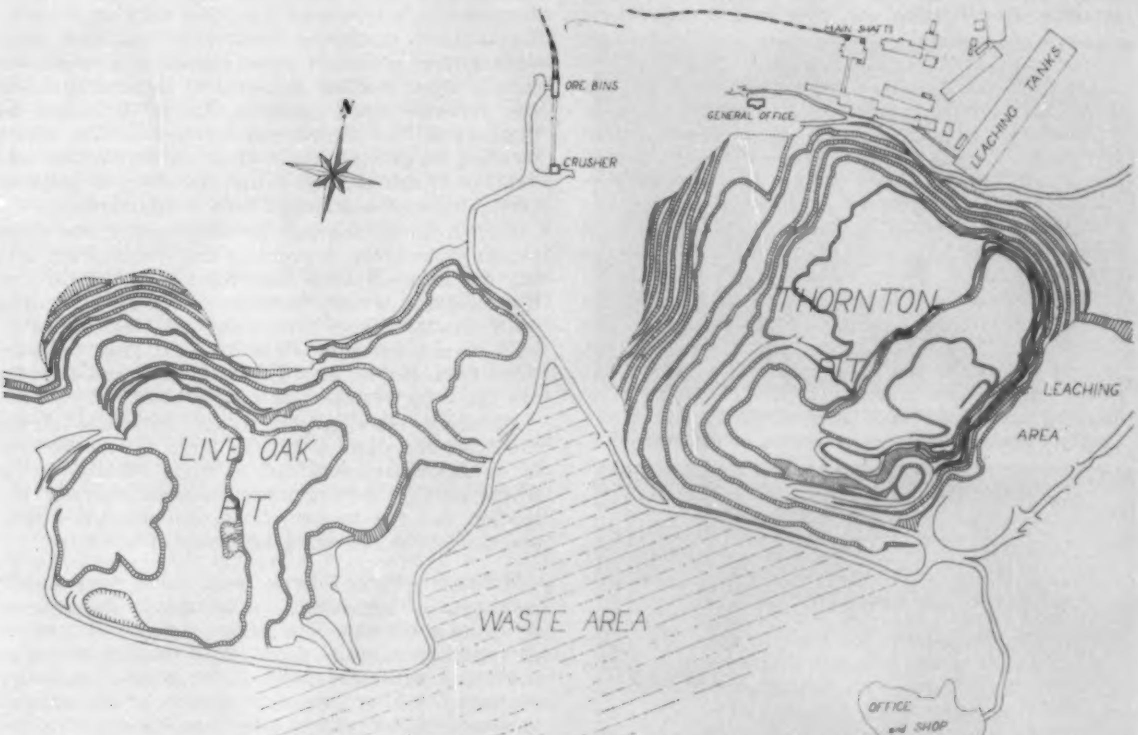
The drill was placed in operation in June 1959, and its performance to date has satisfied the company's hopes and expectations. The drill is scheduled to operate only one shift per day, and on this schedule, it has been more than able to keep up with the drilling requirements. A typical example of its mobility and potential occurred in one particular shift in which the drill worked in both pits, on three separate benches and drilled a total of 360 ft for the shift. The drill can "knock-down", move from one pit to the other (an average distance of 2.5 miles by road) and set up to be ready to drill in less than 30 min. elapsed time. For the month of August 1959, the drill averaged 1.1 moves per operating shift, with the distance traveled per move averaging 7,900 ft.

Table 1 shows the comparison of costs for the 9-in. and 6¼-in. mobile drills and the 9-in. churn drills. The most significant figure is the per ton cost figure which, relative to the 1955 churn drill cost is 0.6 to 1. Table II gives some additional performance data for a comparison between the 6¼-in. and 9-in. rotary drills.

CONCLUSION

Had there been no available truck suitable for a drill mounting, a track-mounted 9-in. drill would probably have been purchased. Certain steps would have been taken to facilitate its moves, but it was felt that the lost time due to the constant moving over the distances required at this site would have necessitated two drill shifts per day instead of the one daily shift which is preferred.

In using the present method of mobile rotary drilling, it was necessary to sacrifice, for the sake of mobility, some performance, stability, and ruggedness which a track-mounted drill would have over a truck-mounted drill. To prove conclusively from a cost standpoint that a truck-mounted rotary is more economical than a track-mounted rotary would be difficult because of the many intangibles involved, and the fact that a track-mounted rotary has not been used at Inspiration. However, it can be said that the drilling requirements at Inspiration have been satisfactorily met with a truck-mounted rotary drill.



"Undercut areas" cover the northern half of the Thornton Pit and the northwest portion of the Live Oak Pit.

A Guide to

CONTINUOUS FILTRATION OF PRECIPITATES

Application of continuous filtration to precipitate dewatering requires not only careful equipment selection, choice of appropriate media, but also close control of precipitation technique itself.

by R. C. EMMETT and D. A. DAHLSTROM

Advances in hydrometallurgy during recent years resulted in greater attention being focused on the various unit operations involved. Some steps, similar to normal beneficiation practice—crushing, grinding, classification, etc.—are well known.Others—roasting, leaching—have recently been intensively investigated from both theoretical and practical viewpoints. Less well-studied are such operations as precipitation and precipitate filtration. This article reviews current practice and presents general principles helpful in planning precipitation and precipitate filtration steps in new and untried processes. Continuous filters have been successfully and efficiently used in the potash, salt, and similar fields for many years and these fields will not be considered here.

Precipitation is usually used to remove impurities from a solution, or to recover a desired component in a pure state. In most cases, precipitates must not only be dewatered, but be washed free of the mother liquor. Also, most precipitates are relatively slow filtering, and these two factors—purity and filterability—greatly influence selection of filter type.

CONTINUOUS FILTERS SUITABLE FOR PRECIPITATES

The drum filter, or its variations, is the most widely used continuous filter for precipitates. The advantages of drum filters are the following:

1) They are suitable for washing the filter cake.
2) Changes in the physical characteristics of the precipitate cause less difficulty on drum filters than on other types of machines.
3) Drum filters are adaptable to different methods of cake discharge, each with its own advantages, as described below:

String Filters: In this design, strings running circumferentially around the drum, over a discharge roll, and back over a return roll onto the drum again are used to lift the filter cake away from the filter medium. This unit is employed where the standard air blow discharge does not work satisfactorily, or where the cake is not sufficiently tacky for a roller discharge. Preferably the filter cake should have a certain cohesiveness, to prevent the strings from pulling through it. Depending upon this cohesive force, cakes as thin as ⅛ in. can be discharged, but the normal for most string filters working on precipitates is about ¼ in. Another advantage of this method is that blowback of solution remaining in the drainage deck is eliminated.

String filters are not suitable where the cake cracks excessively, preventing the strings from lifting the cake off as a solid mass. Blinding of the filter medium is more common, as the air blow used on a standard drum filter helps maintain the cloth in a more permeable state by dislodging accumulated fines. Hence, thin, relatively permeable media are required, resulting in poorer clarity.

Abrasive slurries will cause excessive string breakage and cloth wear. On large filters, the cost of string replacement can be high. Finally, string filters usually require more frequent operator attention, as a few broken strings can result in a substantial loss in operating efficiency of the filter.

Roller Discharge Filters: Tacky cakes, particularly gelatinous precipitates, are adaptable to removal by roller discharge. This device consists of a roller driven in an opposite direction of rotation and synchronized with the speed of the filter. The roller contacts the filter cake, and because of the greater tendency of the cake to adhere to the roll it is removed by it, and then discharged from the roll by means of a scraper. With very tacky materials, the

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roll is usually precoated with as much as an inch of filter cake solids. The scraper is retracted accordingly, so as to trim off only the newly picked up filter cake. Less adhesive, more granular materials are better removed by employing no filter cake layer on the roll, and in these cases the use of an air blow sufficient to inflate the cloth against the roll is often desirable.

The advantages of a roll discharge are similar to those applying to the string filter, except that even thinner cakes can be removed. Cracking cakes present no problem, as long as the stickiness of the material is sufficient to promote adhesion to the roll. A roll discharge filter will be slightly less expensive, easier to operate and maintain, and require less operator attention than a string filter. All other factors being equal, the choice between the two usually will favor the roll discharge.

One of the disadvantages is similar: blinding sometimes requires the use of thin, porous cloths, with resulting poorer clarity. A roll discharge depends upon a certain tackiness of the cake. Hence, a precipitate which varys from day to day—becoming either excessively wet, or dry and slightly granular—will not be a good application for a roll discharge.

Continuous Belt Drum Filters: This type of filter is a newcomer, developed from an earlier machine employing a woven stainless steel belt, in use since 1956. The first application in the hydrometallurgical industry was at the Calera Mining Co., in 1958, where a 6x6 ft unit was used for filtering gypsum precipitate from cobalt solution.

In this unit the filter medium is removed from the drum, goes over a discharge roll, an aligning roll, a return roll, and then back to the drum. No caulking is used, and a seal between sections of the filter and at the ends of the drum is maintained by pressure of the cloth against a pliable rubber ridge. Since the filter medium is removed from the drum, it can be continually washed or treated with reagents if necessary. Furthermore, because no caulking is required, cloth changing takes but a small fraction of the time normally needed on a standard drum filter.

This filter finds principal application where rapid blinding of the filter medium occurs, where the filter cake must be sluiced off the medium, or where a thin cake which cannot be removed by other methods is formed. The specific advantages of the unit over the other systems are, generally, higher rate of production because a thinner cake can be discharged, lower filter media costs, and consistent results despite changing nature of the precipitate, due to the positive discharge and the cloth washing features.

One possible disadvantage of this type of unit for precipitates exists where it is necessary to use a continuous spray wash of the cloth, as some of the precipitate solids will be collected in the wash water. In this case provision must be made to recover the solids if this is not a waste product. Depending upon the flow sheet, it may be possible to recirculate the wash solution to the process as make-up water or to use the mother liquor for washing, thus avoiding dilution upon recirculation. As an alternate the wash water can be recirculated through a small settling tank and the solids which are collected in this manner returned to the filter feed.

Fig. 1—A continuous belt drum filter operating on gypsum precipitate. Note clean discharge and even cake formation on highly blinding solids.

Fig. 2—Continuous belt and standard drum filters handling similar precipitates.

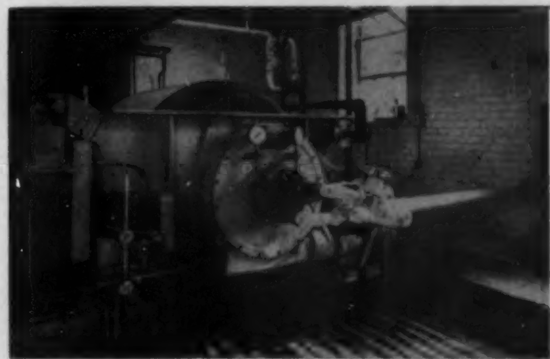


Fig. 3—A continuous vacuum precoat filter of high submergence type.

Fig. 4—A 210 sq. ft tilting pan filter used to filter and wash gypsum precipitate free of phosphoric acid.

Precoat Drum Filters: This unit employs a bed of precoat—usually diatomaceous earth—initially at a thickness of up to 3 inches, to serve as the filter medium and retain the solids on its surface. A slowly advancing knife simultaneously trims off the filtered solids plus a thin (0.0005 to 0.01 in.) layer of precoat as the drum revolves.

The application is usually for slow filtering materials or very dilute suspensions which will not form a cake that can be discharged by the previously described means. Where perfect clarity is needed, this filter is very satisfactory. The advantages are, generally, high capacity, consistently good filtrate clarity, and adaptability to changing feed conditions (variations in percent solids, physical characteristics of precipitates, etc.).

Its disadvantages are these: the precipitate will be contaminated with the precoat, which is usually either a silica or a carbon compound. Second, the cost of the precoat material is substantial, making this filter the most expensive to operate. For estimating 25¢ per 1000 gallons of filtrate is about average for precoat material cost on a good application.

A precoat filter should be avoided where crystallization can cause blinding of the bed, or where the solution would attack the precoat material. If the filter cake cracks badly, then it is apt to cause excess consumption of precoat because of a tendency of the cracked portions of cake to curl up, sometimes lifting about 1/32 in. of precoat material at the same time.

Horizontal, Top Feed, and Internal Drum Filters: The second basic type of filter used in metallurgical practice is the horizontal unit. Top feed filters and hopper dewaterers, although they are drum type filters, fall into this class of application, for free filtering, usually heavy, granular solids. Likewise, the internal drum filter is used in these applications.

Of the horizontal units, two are more frequently used—the scroll discharge table filter and the tilting pan filter. Horizontal belt filters have in general turned out to be too expensive to operate and maintain and their use is becoming much less common.

Comparing these two units, the scroll discharge filter is satisfactory where a free filtering, non-friable substance is to be handled. Dewatering time is not critical, but practical limits do exist. Cake thicknesses usually should exceed an inch. Washing is possible, and in some instances wash separation and multiple stage washing can be employed successfully.

Disadvantages include these factors: Blinding of the media can be a problem, slowing the dewatering rate. The scroll will cause degradation of crystals which are brittle and soft. Unless the filter is operated at a slow speed, it is difficult to effectively separate wash and strong filtrates, especially where two or three stage washing is desired. On abrasive materials, wear on the scroll becomes a factor.

Tilting pan filters are used to circumvent some of of these difficulties. In this unit, a number of pans arranged in a circle rotate around a center axis. Each pan in turn receives feed, the cake is dewatered and washed, then the pan is inverted to discharge the filter cake. In the inverted position, the pan can be washed from below if necessary. The pan is then returned to its original position to receive the feed slurry.

This type of filter has these particular advantages: adaptable to cloth washing, total discharge of the solids, no degradation of the crystals, and good control of solutions for multiple stage washing. The higher cost of the pan filter limits its application.

Top feed filters are employed for free filtering materials which dewater rapidly. These machines normally have high capacity, because high speed of rotation can be used. Spray washing can be employed, though wash separation is not practicable.

Dewatering time is the main limiting factor. Usually the slurry should dewater to the desired cake thickness in less than 0.1 minute. Blinding has to be minimized to maintain this short form time, and for this reason a porous cloth or a screen is employed. Hence, solids must be expected in the filtrate. Approximately 75 pct of the filter can be used for drying, except in the case of very heavy, coarse material where insufficient vacuum exists to retain the cake on the drum beyond the bottom dead center. In these instances, only 50 pct of the area is employed.

The internal drum filter has many of the same advantages and limitations as the top feed filter, except that a maximum of 50 pct of the available area can be used, and initial dewatering time is not critical.

The remaining type of continuous filter, the disk, is widely used in mineral beneficiation. However its application to hydrometallurgy, particularly on precipitates, is rare, probably because washing, which is usually required, is not practical on a disk filter, and therefore multiple stage repulping and filtering must be used. Blinding is common in precipitate filtering and this affects both the capacity and the discharge of the disk filter. Only in cases of a free filtering precipitate that does not require washing is a disk filter likely to be considered.

FILTER MEDIA SELECTION

Selection of the best cloth for a particular process from the hundreds of different cloths now available is confusing, to say the least. In general the synthetic fabrics will give better service on precipitates than the natural fibers, primarily because of their better discharge characteristics and lesser tendency towards blinding. Synthetic materials are usually multi or monofilament, as opposed to the spun staple natural fabrics, and hence are more resistant to penetration of the yarn strands by solids

- *Fine, slimy precipitates* are best handled on thin, tight fabrics of twill or satin weave. Cloths weighing less than 5 oz per sq yd, with an average thread count of about 150 x 100, and an air permeability of less than 10 cfm per sq ft at 0.5 in. water gage, are in this class. Usually these cloths are heat treated and calendered, which lessens shrinkage due to heat and creates a smooth surface, thus aiding discharge.
- *Slightly coarser materials,* having some particles approaching 50 micron size, will be handled well by thin, plain weave fabrics, some monofilament media, and in some instances, cotton fabrics of varying weight, but preferably of twill weaves.

• *Precipitates containing a wide range of particle sizes*, including slimes, are best filtered on monofilament cloths. The solids settle rapidly, and if the medium blinds due to the slimy material, the flow rate through the medium will be too low to pick-up the coarser material. Operation of the continuous filter will produce very uneven cakes, adversely affecting wash efficiency and cake discharge. The monofilament medium will generally allow the first slimes contacting the cloth to pass through with the filtrate, and the solids in contact with the medium will be coarse material, promoting a higher flow rate. Gypsum precipitate with small amounts of aluminum and iron hydroxide present is a typical example.

• *Coarse, granular precipitates* are best handled on screens, monofilament cloths, or, where clarity is important, on light weight, medium porosity, multifilament fabrics. Heavier media (10 oz and greater) will give good clarity and high resistance to abrasion, but in many instances rapid blinding of the cloth will occur. The result will usually be uneven cake formation, loss of washing efficiency, and poor discharge.

PRECIPITATION METHODS

The reasons for considering precipitation as an important step in any process are that this operation will have substantial bearing on the type, size, and cost of the equipment to be used to recover the precipitate, it will affect the purity of the product, and it will determine to some extent the degree of recovery (or loss) of the valuable product. It is usually true that a precipitate which is easily dewatered can also be readily washed, thus insuring the necessary purity or elimination of valuable solution, and it will be recovered more completely from the slurry. Thus, steps which will insure the formation of an easily filtered precipitate will help fulfill the requirements listed above.

Analytical chemistry techniques for preparing easily filtered precipitates call for addition of precipitating reagents slowly, to boiling, agitated, dilute solutions, followed generally by a period of continued boiling or aging for completeness of precipitation and formation of large size crystals.

In plant practice it is rare indeed when all of these criteria can be met. However, it will generally be true that if the precipitating reagent is rapidly dispersed (but without high shear agitation that would result in the mechanical degradation of the crystals) in the solution, either dilute or concentrated, and a suitable aging time allowed, good results can be obtained. If the solution is hot, this generally helps, and in some cases it is absolutely necessary. In others, ambient temperature precipitations are satisfactory, particularly if the precipitation is a slow process. Recirculation of seed crystals is practiced in some cases, in others it is of no benefit, or even detrimental.

To illustrate these principles, cases taken from actual plant practice or laboratory experimentation will be considered for various systems.

Solid Precipitants: Instances of the use of solid precipitating reagents are common. Among them are the precipitation of copper on scrap or sponge iron, recovery of gold and silver from cyanide solutions with zinc dust, precipitation of cadmium and other impurities from zinc leach solutions, also with zinc dust, and uranium precipitation from acidic ion exchange or solvent extraction solutions with magnesium oxide. Neutralization of sulfuric acid solutions with lime or limestone slurries is a very common practice. These precipitates are characterized by being coarse, granular, free filtering, and frequently contaminated with the precipitating solid, if it is coarse and not readily soluble in the mother liquor. Most of the precipitations are rapid and carried out with uncomplicated equipment at room temperature. Usually the reactions are almost 100 pct complete. With precipitations involving iron and zinc, this is simply reduction of the less active, dissolved metallic ion by a more active metal. As a result the precipitate is produced in the elemental state.

With the magnesium oxide precipitation of uranium, the slow dissolution of the oxide causes gradual neutralization of the acid, promoting the precipitation at a higher pH of the uranium as a diuranate salt of any convenient ion present, usually sodium. Thus the precipitating reagent does not even enter into combination with the precipitate but simply controls the rate of precipitation, promoting good crystal growth. The uranium could be precipitated by adding all at once an equivalent amount of rapidly soluble base. However this precipitate would be gelatinous, difficult to filter or wash, and for all practical purposes, a very undesirable material to have to recover economically from the solution.

The precipitation of gypsum, $CaSO_4 \cdot 2H_2O$, from acidic solutions using hydrated lime or limestone is commonly found in many flow sheets. Plant practice has shown that the following steps are important: The reagent should be added as a slurry to insure complete reaction. Particle sizes above 100 mesh will usually not enter into the reaction sufficiently rapidly to be effective. Slow addition of the slurry over a period of time ranging from 15 minutes to one hour will promote better crystal growth, and filtration rates will be as high or higher than 100 lb per hr per sq ft. Addition of all the lime at once can result in a precipitate filtering at one-tenth of this rate. Ample agitation is desirable, particularly where an acidic solution is to be partially neutralized with lime, such as in uranium yellow cake precipitation where lime is used as a substitute for magnesium oxide, ammonia, or sodium hydroxide, in the first stage of neutralization, to a pH of 3. If insufficient agitation is used, local high pH conditions around a particle of lime cause precipitation of the uranium as a thin layer around the particle. Since the gypsum cake is generally recirculated to leaching or ion exchange, this results in further consumption of leaching reagent and uses up some of the available ion exchange capacity.

Precipitation with Liquids and Gases: Many new hydrometallurgical processes employ liquid and gaseous precipitants, particularly in the processes for nickel, cobalt, chromium, manganese, thorium, and numerous other less common metals. In a typical case, in the processing of nickel-cobalt ores by acid leaching, the desired metals are recovered from the acid solution by precipitation with H_2S (hydro-

gen sulfide) gas at a pressure of several atmospheres and temperatures above 220°F. At atmospheric conditions the reaction does not take place spontaneously, hence the need for these conditions. The rate of precipitation is described by the equation

$$\log (y_{\infty} - y) = A + Bt$$

where y is the fraction of metal precipitated at time t.

The value of the parameter A is evidently equivalent to precipitation at zero time, and y_{∞} corresponds to the ultimate precipitation obtainable under the operating conditions. The parameters A and B are functions of temperature, H_2S pressure, initial concentration of metal ion, and seed concentration. The seed recirculation is necessary in order to produce a coarse, granular product. Thus, without seed, the material may be 98 pct −325 mesh, and this would pose problems in sedimentation or filtration despite the granular nature of the particles. With 200 pct recycle seed, the precipitate will be only 50 pct −325 mesh, a considerable improvement from the liquid-solids separation standpoint*.

* *Private correspondence, C. S. Simons, Chief Process Engineer, Freeport Nickel Co.*

The time of the reaction is not critical, with 15 minutes being ample. Evidence exists that much shorter times will produce the equivalent results. Agitation, so long as it is sufficient to suspend the solids, is likewise not a critical factor. Introduction of the H_2S gas is into the gas space above the solution, hence rapid dispersion is not called for.

In later processing of these metals, impurities are removed by precipitation in "pipe line" reactors with H_2S gas at Reynolds Number of flow of 5 to 10×10^5, and at elevated temperature. While the pH has some control on the amorphous or granular nature of the precipitate, it was found that this type of precipitation gave better results than achieved with longer times at conditions of more moderate agitation or shear, in conventional agitated tanks in series.

Where precipitation with a gas is spontaneous and rapid, careful control of the dispersion of the gas may be needed. In tests carried out in uranium precipitation, it was observed that if large bubbles of ammonia were added to the solution, the precipitate was gelatinous, the filtration rate slow, and washing was poor. The filter cake moisture was about 50-55 pct. As the degree of dispersion of the gas was increased, the physical characteristics of the precipitate improved, even though the precipitating time and temperature were held constant. For example, at optimum dispersion conditions, the filter cake moisture was reduced to 44 pct and the filtration rate improved fourfold. Corresponding improvement was noted in the other filtration properties.

The use of seed recirculation is critical in certain instances. In the precipitation of nickel and cobalt metals with hydrogen gas, the reaction is completely dependent upon the use of seed, as precipitation will not occur spontaneously. Hence a batch of seed material is prepared with the aid of a catalyst and a series of precipitations (or densifications) carried out on the seed, each precipitation adding a layer of metal to the seed particle. The evidence is that the catalytic nature of the surface of the metal particle serves as a means of activating the hydrogen, thus promoting the reaction. A high degree of agitation is used although it is not known whether this is a critical factor or if less agitation would work just as well. However, above normal agitation is required since the coarse particles settle rapidly.

Use of seed recycle to produce a coarse precipitate is common practice in the Bayer process for production of alumina. Here, the recirculation of about 150 pct seed, followed by gentle agitation for 50 to 60 hours, accompanied by slow cooling of the saturated solution, results in the formation of particles generally 95 pct +325 mesh in size. If precipitation were carried out rapidly without seed, a gelatinous aluminum hydroxide would result. This would naturally be very undesirable for the process.

To illustrate a case not readily solved in the laboratory, the following example is typical: In aluminum hydroxide precipitation from chrome ore leach liquors, concentrated sulfuric acid is injected to lower the pH from 12 to 8. The method of injection of the acid and the conditions of agitation completely control the nature of the precipitate. The acid must be rapidly dispersed in the form of size droplets. In conjunction with this the agitation cannot create too much shear and destroy the delicate crystals formed. Close inspection of these crystals shows them to be clusters of much smaller crystals. They are formed under ideal conditions in large scale equipment, and filter and wash readily. However in the laboratory or pilot plant, the degree of agitation sufficient to disperse the sulfuric acid also breaks up the crystal. The result is a filtration rate about half as high as obtained in full scale operation. Fortunately, such cases are very rare.

Summarizing precipitation techniques, the following generalizations can be made:

1. Precipitation with solid reagents will usually require prewetting of the reagent, the use of fine size material, and ample agitation, unless it is simple oxidation-reduction, metal ion to metal, where no special provisions are needed.
2. With gaseous precipitants, where the gas is highly soluble in the liquor (i.e. ammonia in acid solution), good dispersion of the gas is desirable. High temperature and rapid agitation but without excessive shear are also helpful.
3. With gaseous precipitants under less soluble conditions (H_2S in acidic solutions) high pressure and high temperature and sufficient mixing of the suspension will be important factors.
4. Where coarse, granular precipitates are desired, recirculation of seed crystals will be a necessary factor.

LABORATORY TEST PROCEDURES

Pilot plant testing on a continuous filter is the most reliable method of determining filtration requirements for hydrometallurgical precipitates. This is not always possible, usually due to cost, and it is common practice to use batch filters for the precipitate steps. Thus, laboratory techniques will be important in the sizing of the filters. These tests must be made carefully and the data properly interpreted in order to insure a good installation. Previous papers have described these methods in detail.[1,2]

[1] A. P. R. Choudhury and D. A. Dahlstrom: Prediction of Cake Washing Results with Continuous Filtration Equipment. *Chemical Engineering Journal*, Dec. 1957.

[2] C. F. Cornell, R. C. Emmett, and D. A. Dahlstrom: Engineering Continuous Filtration to the Uranium Ore Processing Flow Sheet. *Chemical Engineering Progress Symposium Series*, No. 22, Vol. 55, Nuclear Engineering Part V.

A Career of Human Significance

by Wayne E. Glenn

The years immediately ahead—1961, 1962, 1963—will be critical years from every standpoint for the young engineer. In the next few years, he must learn to grow professionally. Most often, the rate and extent of this growth will be governed by his own initiative and perseverance. Habits and attitudes acquired during these early professional years relate very closely to, and even foreshadow, future accomplishments.

The future goal of the young engineer is a moving target. It will change with professional growth, family requirements, changes in predominant interest, general economic and business conditions and geographic location. However ambitious and steadfast in his goal he may be, the young engineer should not hesitate to adjust or change—for he really does not know initially what he is best fitted for and will not know until he has tried a number of things patiently and persistently.

Professional development in specific technical competence and, broadly, as an individual and as a citizen will have many facets. To achieve "A Career of Human Significance" will require a well conceived plan, properly timed and executed. The successful engineer will need to maintain a thirst for knowledge throughout his career, for one of his critical personal problems will be the constant pressure to keep up with the parade of advances and new findings in the profession—to escape what might be termed "technological obsolescence".

TECHNOLOGICAL OBSOLESCENCE

The problem can be stated as a paradox. The engineering graduate leaves college partially educated for his career. Nevertheless, at that time he may possess a wider range of detailed scientific and technical knowledge than he will at any later stage of his career. To maintain the highest level of technical "know-how" calls for a life-long study habit.

One of the industry's major problems today is how to help "re-tread" the engineer who has been out of school 10 years or more and is holding a responsible position. Many of the engineers working for him may be more technically competent than he. As a result, he may be unable to assist them or even to pass expert judgment on some of their more "long-haired" calculations and ideas.

WAYNE E. GLENN, 1960 President of the Society of Petroleum Engineers of AIME, is with the Continental Oil Co., Houston, Texas. A more detailed version of this paper was delivered as a commencement address at Montana School of Mines on June 6, at which time the author received his honorary doctorate degree. This version is reprinted from the September 1960 issue of *Journal of Petroleum Technology*, official publication of SPE.

There does not seem to be any short-cut or easy way to re-tread these "oldsters". The men who face technological obsolescence will be passed by—and their juniors will become their "bosses" unless they can be refreshed. But how much better off they would be if they had kept up-to-date. To compound the problem, while the technically retarded are catching up, the young or more alert engineers are moving ahead—growing both intellectually and in judgment. This professional "middle-age spread" must be avoided.

USING TIME WISELY

As an individual, each engineer will have to face up to the problems of handling his job responsibilities and of continuing his education. The organization for which he works may assist in some formal training, but growth is his responsibility. Others can offer the opportunity, but he alone must do the learning.

Galileo, the Italian scientist and philosopher, said "You cannot teach a man anything—the very most you can do is to cause him to discover it within himself".

One cannot afford to postpone the continuance of his education or accumulation of knowledge. Once he loses good study and reading habits, he may find them difficult or impossible to regain.

Future educational growth will take two forms. One will be of a daily nature—as areas needing improvement are noted, work to correct this lack immediately. The other is a long-range educational program, which will require more thought in its preparation and execution.

Although everyone will almost certainly be "derailed" once in a while on this long-range program, he should try not to become discouraged. Rather, he should attempt to get "back on the track" just as quickly as possible.

DEALING WITH PEOPLE

But even the highest degree of proficiency in engineering will not, in itself, give assurance of a full career—"A Career of Human Significance". In the first place, each engineer will be working for and with other people with other skills and knowledge. Somehow his career must dovetail with the skills, knowledge, hopes and aspirations of all those other people. This career will not be a one-man show. And, for what may seem a long period of time, he may appear to be selling popcorn in the lobby rather than holding the center of the stage with a spotlight on him.

The world today is obviously more complex than ever before. There are more people, more electron-

ically controlled machines, more processes and more experts in bigger companies producing more goods for the seemingly insatiable demands of an ever growing modern civilization. In this complexity, the individual feels lost. He feels there is little chance for individual recognition or individual dignity. He is in a corporate body which has become terrifyingly efficient, sophisticated and knowledgeable. But remember, the company is made up of people, and its growth is the result of people's effort.

The young engineer runs into problems which cannot be solved on a slide rule or a computer. No pat formulas seem to work. During this period, his relationship with the people around him will mean as much toward his success as his technical proficiency. In fact, to achieve a position of leadership among men, he will have to show as high a degree of human relations ability as he has technical proficiency. Human relations is nothing more than an understanding of the needs, the hopes and the aspirations of colleagues—and recognizing the qualities that make them unique individuals and members of various groups. As he develops this ability to deal with people, in effect the engineer will be broadening his scientific horizon to encompass the newer, younger and less exact sciences of psychology and sociology. These social sciences give some insight into the most complex horizon of all—man himself!

We need the right men; we also need the right atmosphere for work. Highly skilled and professional men need less supervision; they are more deeply motivated by the challenge of the job. But they are no different from other employees in their search for recognition, status, responsibility and the challenge of new projects.

The danger is that, because these men are more highly educated and more skilled, we may assume they will need less concern with their problems of human relationships.

A scientist who headed a group of scientists working during World War II on the proximity fuse wrote the following.

> If there is anything characteristic of the way we ran Section I it is the idea of recognizing problems of the spirit. Very often what we ran into was not a technical difficulty, it was a spiritual difficulty. We recognized this constantly. You encounter it — the problems between people. The word "spiritual" is ordinarily very frightening to scientific men. It brings them up short. You can handle the physical world in terms of the laws of nature and the rules of technology, but as an intelligent person you must recognize constantly the fact that human awareness and motivation and the satisfaction of the spirit is truly another type of fabric; these things are not governed by the laws of the physical world.

Of course, what this means is that experience in human relations or "training" will continue to be important. It will take the kind of understanding of human relations we saw expressed in Section I to get the job done.

But this is not all—because the young engineer will find himself increasingly perplexed by problems of finance, accounting and economics. He will discover that engineering, as an applied science, depends for its acceptance on various basic economic concepts such as whether the total cost of a project exceeds its potential worth—what will the buying public pay. He can research or experiment some, but finally the idea or project must pay for the research plus all other costs and make a profit. These are hard facts which will sometimes prove frustrating when promoting a gem of an idea. There are many worthwhile engineering projects to pursue and a shortage of ideas as to how to accomplish them economically.

Thus, one finds himself working with accountants and financial wizards. To do so, he must learn their language.

YOUR COMMUNITY RESPONSIBILITY

Beyond the technical and business world lies an even broader horizon—the community. An engineer who restricts himself to his profession and his job in the business world finds life pretty incomplete. He must undertake his responsibility as a citizen to his community, his church, professional society and his nation. In the last analysis, he has to become a citizen, along with other professional and business leaders, whether they be doctors, lawyers, storekeepers or bankers.

Engineers have proved they are capable of overcoming every technological problem they face. They represent the best minds in the world. They are able to get the facts and understand them. As a profession, they enjoy the respect and admiration of all people. But what have they done as a profession to show they are capable or even interested in solving the economic, social, political and governmental problems of their community, state or nation? What do we know of our local and state politics and governmental affairs?

Many engineers may be amazed to learn that being active in precinct politics, school board, an active engineers' society, teaching night classes in school, church work, little league baseball, etc., can help him find a hometown market for leadership. These activities are certainly better than tranquilizers in helping him overcome an imagined sense of arrested progress in professional life. In addition, they provide an opportunity for public speaking, learning to know people and organizational planning. These skills must be developed as early as possible. The mistakes made at the beginning will not be so critical as those which might be made at the top.

THE SUCCESSFUL MAN

Can one man find time to be proficient in all of these activities and still have time for his family and himself? Many men do all of this and more. We are talking of the successful man, the man who really enjoys "A Career of Human Significance". The degree of success to be attained must be determined by each individual. Success means various things to various people. In one case success may mean international acclaim and great wealth, while another man may be perfectly happy if he wins the title of "Biggest Midget in the Block".

The careers of successful men reflect at least one universal characteristic—the wise utilization of time. The truly successful man does not delude himself by offering such rationalizations as "I just didn't have the time", as an excuse for not accomplishing what he wants to accomplish. The difference between success and failure is, often, productive use of time accomplished through effective budgeting of time.

In summary, the engineer's career should be the career of a true citizen. It should be broad enough in scope to encompass participation in family, community, religious, political and professional activities. He must have an insatiable thirst for knowledge about people and things, avoiding technological obsolescence and acquiring a knowledge of over-all business affairs. The secret to good human relations lies in an understanding and application of the "Golden Rule".

SME BULLETIN BOARD

Reports of Your Technical Society

90th AIME Annual Meeting

These Are the Dates: February 26 — March 2, 1961

This Is the Place: Chase-Park Plaza Hotels, St. Louis

Program and Abstracts Appeared in December on Pages 1239—1249

Speaker at SME Dinner

CURTIS L. WILSON

Curtis L. Wilson, Dean of the Missouri School of Mines and Metallurgy and Director of the State Mining Experiment Station, will be the speaker at the SME Dinner on Tuesday, February 28th. A native of Baltimore, Dr. Wilson moved West to attend the Montana School of Mines, where he graduated with an E.M. degree. Later he received his Ph.D. in metallurgy from the University of Goettingen in Germany. Distinguished as a teacher and administrator, he has written many technical articles and is co-author of a textbook on copper metallurgy.

REPORT OF 15TH OFF-THE-RECORD MEETING

Russ Rohleder, guest speaker, addressing Fellowship Dinner about Project Mercury.

F. R. Cortez addressing the Institute of Metals session at Off-the-Record Meeting.

Harold Rowen presenting John Hansen's paper during Mineral Industry session.

The 15th Off-the-Record Meeting of the Pittsburgh Section got under way with a dinner dance Thursday evening, November 3, in the Terrace Room of the Penn-Sheraton Hotel. The following morning registration began. Each year on the first Friday of November the AIME Pittsburgh Section, the National Open Hearth Committee, the Coal Division of the Pittsburgh Section, the Petroleum Subsection, the Institute of Metals group, and the Mineral Industry group cooperate in sponsoring this meeting. Each group holds two technical sessions at which papers are presented by representatives of manufacturers, operators, and scientists. The papers are not for publication, nor is the lively discussion which they provoke.

The morning session of the Coal Division was chaired by Woods G. Talman of U.S. Steel Corp. Topics of the papers were: an up-dated presentation of pressure-arch theory and related matters by Charles T. Holland; core drilling by N. M. Spanos; and a description of the latest model of the Joy Push Button Miner by E. M. Warner. The afternoon session dealt entirely with the flotation of coal. J. J. Reilly, of Jones & Laughlin Steel Corp., was Chairman. H. A. Feazelle, Armco Steel Corp., pointed out how his company has increased plant yield through the use of froth flotation. R. E. Joslin described methods used at the Morse No. 3 mine by Clinchfield Coal Co. H. E. Steinman, of Jones & Laughlin Steel Corp., told how his company disposes of the large amount of refuse and slimes that result from the use of froth flotation.

E. S. Wheeler, Climax Molybdenum Co., and John Winters, St. Joseph Lead Co., were Co-Chairmen at the morning session of the Mineral Industry group of the Pittsburgh Section. N. B. Dell spoke on reactions between carbon potlinings and the Hall Bath. Warren Mahan reviewed the U.S. Bureau of Mine's experimental blast furnace operations; Philip Woolf, project leader for the operation, was a co-author of this paper. John Hansen's paper on modern sintering plant instrumentation was ably presented by Harold Rowen, since Mr. Hansen could not be present. The session closed with a paper on an investigation of particle size determination by George Grimes. At the afternoon session George W. Josephson, USBM, and James D. Dowd, Alcoa Research Laboratories, served as Co-Chairmen. Marlyn J. Ackerman spoke on research in hydraulic mining; Frank M. Stephens, Jr., presented a paper entitled *Extractive Metallurgy in the Atomic Age;* Edward S. Kurzinski spoke on new uses for oxygen in steel-making for nonferrous use; and Wesley C. L. Hemeon outlined recent legislative developments with respect to air pollution. The session ended with the showing of a film entitled *Refining Nickel from the Sudbury Ores,* contributed by the International Nickel Co. Inc.

One of the highlights of the meeting was the Student Affairs Session at which William H. Meanor, coordinator, personnel procurement for Allegheny Ludlum Steel Corp., spoke. The title of his paper was *Your Best Foot Forward.* In the course of his talk he advised an audience of about 100 students on how to conduct themselves during a job interview. He covered a wide range of topics, from how to dress, to what questions to ask.

At the close of the morning sessions participants gathered for an informal luncheon at which AIME President Joseph L. Gillson presented certificates of appreciation to a number of Past-Chairmen of the Pittsburgh Section.

That evening everyone met in the Main Ballroom for the Annual Fellowship Dinner. Many members bought extra tickets so students attending the meeting could take part in the social activities as well as the technical sessions. This custom has become a regular feature, over the years, of the Pittsburgh Section's work with student members. At the dinner AIME President Gillson spoke very briefly on AIME membership. His theme was, *What Do I Get for My $20.* (N.B. See page 1276, Decem-

The Off-the-Record Meeting gets off to a lively start with a dance held in the Terrace Room of the Penn-Sheraton Hotel.

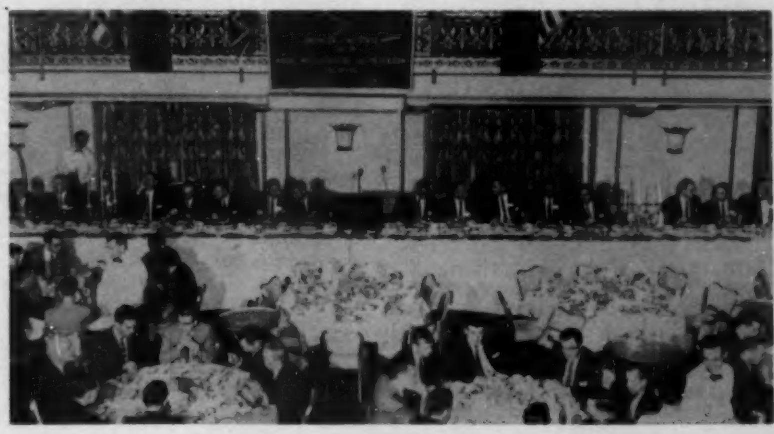
Another social highlight of the meeting was a cocktail hour, sponsored by suppliers, following Friday's technical sessions.

ber 1960.) Speaker of the evening was Russ Rohleder of Bell Telephone Co. who spoke on Project Mercury. This is the Astronaut Program that will put a man in a space vehicle into orbit around the earth sometime in 1961 or 1962. After he finished his talk, Mr. Rohleder answered many questions from the audience and neatly sidestepped those that called for information still *Classified.—J. C. Fox, Secretary, Society of Mining Engineers.*

Right, the founding fathers of the Off-the-Record Meeting: George Donaldson, Hugo Johnson, and Linwood Thiessen.

Pictured below, Past-Chairmen of the Pittsburgh Section who were honored at the Old Timers Luncheon. Back row, left to right: C. L. McCabe, L. Thiessen, E. H. Hollingsworth, and G. Donaldson. Front row, from left to right: N. K. Flint; J. L. Gillson, who made the presentations; E. H. Dix; R. D. Snouffer; and J. M. Vonfeld.

A gala banquet marked the close of this 15th Off-the-Record Meeting on Friday night. The picture below shows the speaker's table while the dinner was in progress.



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Alaska.....Contact Salt Lake City Office

Awards and Honors

To be presented to AIME and SME members during the 1961 Annual Meeting.

James Douglas Gold Medal: *Frank H. Spedding*

Erskine Ramsay Gold Medal: *Donald Markle*

Robert H. Richards Award: *Nathaniel Arbiter*

Daniel C. Jackling Award and Lecture: *Vincent D. Perry*

Hal Williams Hardinge Award: *Raymond B. Ladoo*

William Lawrence Saunders Gold Medal: *Marcus D. Banghart*

Rossiter W. Raymond Memorial Award: *D. W. Fuerstenau*

Charles F. Rand Foundation Award: *D. H. McLaughlin*

AIME Honorary Members: *Rene M. Perrin, Carl E. Reistle, Jr.,* and *John F. Thompson*

Legion of Honor Members: *Joseph Daniels, Abner F. Dixon, Roy B. Earling, Walter E. Hopper, Merritt W. Hotchkin, Charles F. Huber, Augustus Locke, Andrew K. McCosh, Jr.,* and *Francis P. Sinn.*

Marcus D. Banghart

Saunders Medal Award to Marcus D. Banghart

The William Lawrence Saunders Gold Medal for 1961 has been awarded to Marcus D. Banghart, vice president of Newmont Mining Corp. The award was established in 1927, through a gift made by Mr. Saunders, a former president of AIME, to honor achievement in mining other than coal. The citation for the award to Mr. Banghart reads:

"For the development of new mining techniques and overcoming many operating difficulties, resulting in O'okeip and Tsumeb becoming low cost producers under his capable management."

A native of Nebraska, Mr. Banghart attended the Univeristy of Nebraska and, later, the Montana School of Mines. After completing his studies, he spent four years with the Anaconda operation at Butte. Subsequently he worked in Ecuador, Mexico, Nevada, and California.

Mr. Banghart has been associated with Newmont Mining Corp. since 1934, when he became manager of several gold mining subsidiaries in Canada. Since 1940 he has been general manager of O'okiep Copper Co. Ltd. In 1947 the direction of Tsumeb was added to his duties and in 1953 he became managing director of both O'okiep and Tsumeb. He is presently vice president in charge of operations for all the Newmont properties.

Donald H. McLaughlin

McLaughlin to Receive Rand Foundation Award

Donald H. McLaughlin has been named this year's recipient of the Charles F. Rand Foundation Award, which was established in 1932 to honor distinguished achievement in mining administration.

Dr. McLaughlin, a native of San Francisco, is president of Homestake Mining Co., with offices in San Francisco. Following studies at the University of California and Harvard University, he went to work as a geologist in secondary enrichment investigation in Cambridge, Mass. From 1919 to 1925 he was chief geologist for Cerro de Pasco Copper Corp., Oroya, Peru.

Upon his return to the U. S. in 1925 he combined work as a consulting geologist with an academic career, first at Harvard and later at the University of California. This was interrupted in 1944 when he returned to Peru for a year as general manager for Cerro de Pasco Corp. To mention only a few of the highlights in his career, Dr. McLaughlin has been chairman of the Advisory Committee on Raw Materials of the Atomic Energy Commission; chairman of the National Minerals Advisory Committee; and a member of the Committee on Natural Resources, Hoover Commission.

Paralleling all of these activities has been his 30-year association with Homestake Mining Co, of which he is president.

First Jackling Lecturer to Present 1961 Award

This year's Jackling lecturer, as announced earlier, is Vincent D. Perry. He will deliver his lecture at 2:00 pm in the Khorassan C Room of the Chase Hotel in St. Louis. Mr. Perry will be introduced by the first recipient of the Jackling Award, Reno H. Sales, under whom he worked during his early years with Anaconda in Butte.

The citation honoring Mr. Perry reads:

"For his contributions to geology and geophysics; his leadership in their application to the finding and developing of mines, and for his lecture *The Significance of Mineralized Breccia Pipes.*"

Fuerstenau Receives Award for His Paper

Douglas W. Fuerstenau has been selected to receive the 1961 Rossiter W. Raymond Award for his paper *Retention Time in Continuous Vibratory Ball Milling,* which appeared in the December 1959 issue of MINING ENGINEERING. The Award was established in 1945 through a fund contributed to honor one of the founders of AIME. It is awarded for the best paper published by AIME by one of its members who is under 33 years of age. The papers are judged not only for technical content but also for proficiency of presentation and editorial style.

Erskine Ramsay Award to go to Donald Markle

The 1961 Erskine Ramsay Gold Medal, an award established to recognize distinguished achievement in coal mining in either bituminous or anthracite coal, has been awarded to Donald Markle, president of Jeddo—Highland Coal Co.

Mr. Markle was born in Hazelton, Pa., and following his graduation from the Hill School, Pottstown, Pa., entered Sheffield Scientific School at Yale University. After receiving his Ph.B. from Yale in 1914, he spent two years at Lehigh University studying mining. He began his career as assistant mine foreman at the Cranberry Colliery of Lehigh Coal & Navigation Co. and was later promoted to superintendent of preparation.

It was during these early years that Mr. Markle introduced in the anthracite region tables for the cleaning and preparation of fine sizes of anthracite. He also developed and patented a new fuel, known as *Anthracoke,* made from anthracite fines and coal tar pitch. Another of his innovations was to improve the structure of metallurgical coke by using anthracite fines as an additive to bituminous coking coal.

(Continued on page 57)

Following his service in World War I, Mr. Markle became affiliated with Hudson Coal Co. as a special engineer in charge of research preparation and use of fine sizes of anthracite. He later served as president and chairman of the board of Fuel Service Co., which he and his associates founded in 1921. In 1926 he became president of Jeddo—Highland Co., representing the third generation of his family to head the company.

Meetings to Consider Future of Iron Industry

The 22nd annual mining symposium sponsored by the University of Minnesota's School of Mines and Metallurgy and Center for Continuation Study will be held January 10 to 11 at Duluth. The symposium has been planned in conjunction with the annual meeting of the Minnesota Section of AIME to be held January 9. Registrants for the symposium are invited to attend the AIME meeting. Headquarters for both groups will be in the Hotel Duluth; the sessions will be held in the adjacent Norshor Theater.

Factors Affecting the Future of Lake Superior Iron Ores is the theme of the meetings, which will treat in more detailed fashion some of the important topics introduced at the 1960 meetings. Robert J. Linney, president, Reserve Mining Co., is scheduled to give the keynote address at the AIME meeting. His topic will be *What Are We Doing and What Must Be Done to Meet Competition?*

Other topics to be considered at the AIME sessions are: *Does the Lake Superior Region Have a Future in Nonmetallic Taconites, Basic Research Trends in the Iron Mining Industry,* and *Training Men for the Iron Mining Industry.*

Among the subjects to be considered during the symposium are problems relating to labor, taxes, transportation, population growth, and economics.

Booklet on Gold and Money Now Available

One of the highlights of the Pacific Northwest Metals and Minerals Conference was the Gold and Money Session. The entire proceedings of this highly important session are now available in book form, thanks to the efforts of the Oregon Section of AIME and the cooperation of the State of Oregon Department of Geology and Mineral Industries. (See Books, p. 4.) Anyone interested in the factors affecting monetary policy and the position of gold will find this booklet invaluable. In view of the present widespread concern about the gold market, this is a timely publication indeed.

Mining Symposium Program Announced

Plans for the forthcoming International Symposium on Mining Research to be held February 22 to 25 at Rolla, Mo., have been completed and give promise of a highly informative three-day session. Curtis L. Wilson, dean of the Missouri School of Mines and Metallurgy, and Marling J. Ankeny, director of the U.S. Bureau of Mines, will give the welcoming addresses on Wednesday morning, February 22. The keynote address will be given by Elmer W. Pehrson, chief, Division of Foreign Activities, U.S. Bureau of Mines.

Highlighting the international character of the meeting will be the presentation of papers by Japanese, Swedish, Austrian, and Indian industrialists. Also to be heard are a member of the USSR Academy of Sciences; a professor from the University of Clausthal, Germany; a professor from Ecole Nationale Superieure des Mines de Paris, France; and faculty members of the University of Leeds, England. Representatives from the fields of industry, government, and education in the U.S. and Canada will also present papers.

An active social schedule has been arranged, including two banquets and a smorgasbord dinner.

See You in St. Louis February 26-March 2

With February 26 not much more than a month away, plans for the 90th Annual Meeting of AIME have reached their peak. How about your own plans to "Meet Me in St. Louis"? If you have not done so already, now is the time to make your reservations at the Chase-Park Plaza Hotels. The dates, again, are February 26 to March 2.

Price List Released for 1961 Publications

The 1961 price information for AIME publications has been announced and is given below in tabular form for easy reference.

The new *Society of Petroleum Engineers Journal* will be sent free to those SPE members who request it. A request form was published in the December 1960 and January 1961 issues of the *Journal of Petroleum Technology.*

The Metallurgical Society will, as usual, publish the Conference Proceedings for the three Iron and Steel Division conferences. These are: The Open Hearth Proceedings; The Electric Furnace Proceedings; The Blast Furnace, Coke Oven, and Raw Materials Proceedings. These are available to members for $7 and to nonmembers for $10. An additional charge of 50¢ is made for each book mailed outside the U.S. to nonmembers.

The Metallurgical Society—Interscience Publishing Co. will publish Proceedings of various Metallurgical Society meetings to be held in 1961. The Proceedings are published for their own sale at various prices with a 20 pct discount applicable to AIME members.

Bimonthly Transactions of The Metallurgical Society are available for $5 for the first subscription, $30 for any additional subscriptions in the Americas, and $32 elsewhere. Nonmember rate is $30 in North, South, and Central America and $32 elsewhere.

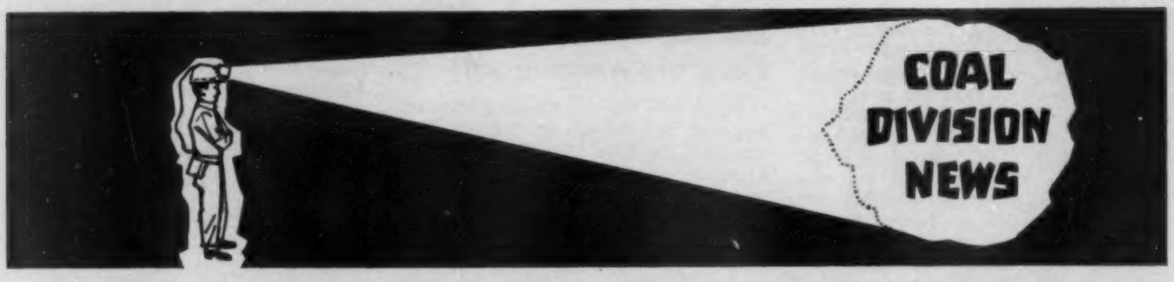
1961 AIME Publications Prices

1960 Bound Transactions Volumes to be Issued in 1961

		MEMBERS		NONMEMBERS		MEMBERS ONLY
No.	Technical Area	Pay with Dues	Pay Later	North, South and Central America	Elsewhere	PAPER BOUND
217	Soc. of Mining Eng.	$8.50	$8.50	$12.00	$12.00	$7.50
218	Metallurgical Soc.	5.00	6.50	35.00	35.00	
219	Soc. of Petr. Eng.	3.50	4.90	7.00	7.00	

1960 Journal Prices

	MEMBERS One Journal with Dues		NONMEMBERS	
	Additional Subscriptions			
Name	Other Journal	Same Journal	North, South and Central America	Elsewhere
Mining Engineering	$4.00	$8.00	$ 8.00	$10.00
Journal of Petroleum Tech.	4.00	8.00	8.00	10.00
Journal of Metals	4.00	8.00	10.00	12.00



COALMEN MEET AT JOINT SOLID FUELS CONFERENCE

Some Optimistic Reports on the Industry's Future

Charleston, W. Va., was the scene of the 23rd annual Joint Solid Fuels Conference, sponsored by the Fuels Division of ASME and the Coal Division of SME. This year's host was the ASME Charleston Section, of which J. W. Mitchell is chairman. Dale C. Calhoun was Conference Chairman.

From every standpoint the meeting was a success. Attendance of more than 200 men and about 40 women broke all recent records for this meeting. Papers were of uniformly high quality and there was time for discussion of each. This time was well spent, for the discussion of all papers was lively and pertinent. The two luncheons and the banquet were well attended and the programs presented on these occasions proved to be timely and interesting.

R. B. Engdahl, left, presents C. E. Lesher with the Percy Nicholls Award. Onlookers from left to right are: D. C. Calhoun, H. D. Zimmerman, W. T. Reid, and E. G. Bailey.

Dunn Addresses Luncheon Meeting

At the opening luncheon on Monday, October 24, with Thompson Chandler presiding, Stephen F. Dunn, president of the National Coal Assn., was guest speaker. He chose as his title *The Future of Coal Is Not Black*. Elaborating on this theme, he quoted Francis Bacon, who said, "Prosperity is not without many fears and distastes; and adversity is not without comfort and hopes."

"At this moment," Mr. Dunn went on, "there appear to be more comfort and hopes than fears and distastes ahead for the coal industry." He traced the ups and downs of the industry since 1929 and analysed the reasons for both. He then outlined the many ways in which NCA is laboring to see that the comforts will be assured and the hopes realized in the years ahead.

Operation Turret to Come to West Virginia

West Virginia's Governor, the Hon. Cecil H. Underwood, chose the occasion of the banquet to make the surprise announcement that *Operation Turret*, the gasification of coal through the use of nuclear energy, will construct a pilot plant in West Virginia at some location as yet unnamed. The Governor's talk was the principal address at the banquet on Monday evening. W. T. Reid, chairman of the ASME Fuels Division, presided.

Highlight of the Joint Solid Fuels Conference was the banquet held Monday night. The picture above caught the audience as they listened to Governor Underwood of West Virginia, at the head table, give his address, during which he announced Operation Turret.

Guests at the head table listening to C. E. Lesher as he expresses his thanks on receiving the Nicholls Award are: H. O. Zimmerman, R. B. Engdahl, W. T. Reid, Governor Underwood, E. G. Bailey, R. R. McNaughton, the Rev. H. P. Light, and J. W. Mitchell.

C. E. Lesher Receives the Nicholls Award

One of the features of the banquet was the presentation of the Percy Nicholls Award to Carl E. Lesher, a long-time (40 years) member of the Coal Division of AIME. In making the presentation, R. B. Engdahl, Chairman of the Percy Nicholls Award Committee, said that Mr. Lesher was chosen because through his notable scientific achievements and his work as editor, engineer, and business executive he had improved the use of bituminous coal.

Mr. Lesher's career in the coal industry spans half a century, beginning in 1910 when he joined the U. S. Geological Survey. Five years later he was placed in charge of coal, coke, and solid fuel economics and statistics in the Mineral Resources Branch of USGS. He subsequently became director of statistics of the National Coal Assn. and served as director of the Statistical Bureau of the U. S. Fuel Administration during World War I.

After four years as editor of *Coal Age*, Mr. Lesher was named assistant to the president of Pittsburgh Coal Co. in 1924. In 1926, while responsible for the control of mechanical coal cleaning, he developed the Disco low-temperature carbonization process and directed the building of the Disco plant in Pittsburgh. He became, successively, executive vice president of Pittsburgh Coal Co. and president of Pittsburgh Coal Carbonization Co., a subsidiary. From 1939 to 1950 Mr. Lesher was president of Lesher & Associates, which he founded as a pilot plant operation for coal carbonization and as a holding company for patents. At present Mr. Lesher carries on a consulting practice in Pittsburgh.

A native of Colorado, he received his professional education at the Colorado School of Mines. In 1949 his alma mater honored his achievements in the field of mineral engineering by awarding him a medal.

Luncheon Travelogue

At the Luncheon on Tuesday Ivor F. Boiarsky gave a talk, *Tour of the Holy Land*, in explanation of a series of slides made from photographs he took during a journey through Israel. He did not dwell on the ancient history of the country but rather on the accomplishments of the modern country that occupies this ancient land.

Following the luncheon, J. W. Mitchell thanked the speaker and those present for coming to the meeting and declared the Conference adjourned.

From left: J. W. Mitchell, H. E. Jones, Jr., H. O. Zimmerman, T. Chandler, Stephen Dunn, luncheon speaker, and W. T. Reid.

Pictured at head table from left: R. B. Engdahl, W. T. Reid, Governor Underwood, speaker, E. G. Bailey, and R. R. McNaughton.

ROCK IN THE BOX

Mining & Exploration Division

M & E Division Annual Business Meeting, 1961

Remember the Mining and Exploration Division Annual Business Meeting in St. Louis:

TIME: 4:30 pm
DATE: Wednesday, March 1
PLACE: Hunt Room, Chase Hotel

At this time the retiring Chairman will transact any essential business and present any reports or call for reports deemed necessary. He will then introduce the new officers and turn the meeting over to the new Chairman. The new Chairman will announce the names of the new Executive Committee and appoint a Nominating Committee. The Vice Chairman and Unit Committee Chairmen will be called upon to present reports of the progress of organization and plans of action of their respective Units. It is particularly important at this meeting to formulate plans and policy for the 1962 Annual Meeting Program.

For the transactions of any business, a quorum of not less than twenty (20) members is necessary. Please set aside this hour in your Convention schedule and plan to attend this important meeting. Lack of attendance in the past has been a problem to your Division officers.

Owing to lack of funds the important Mining and Exploration Division Peele Award has not been made for the past two years. One objective of our Division in 1961 will be the reactivation of the Peele Award.

After a thorough study by special Committees of SME it has been recommended that the Society of Mining Engineers of AIME hold an annual All-Society meeting at a time and place separate from the Annual AIME Meeting. Plans are being formulated for such a meeting in 1963. Your support of this program will foster unity among SME members and aid our Society in discharging its proper responsibilities to AIME.

Members Urged to Make Suggestions at Meeting

Here is your opportunity to unload any "beefs" you may have and offer constructive criticism to your Division officers. Please feel free at any time to express your interest by writing to your officers.—*John G. Hall, Incoming Division Chairman, 1961.*

Mining and Exploration Division Bylaws

Article I
Name and Object

Section 1. This Division of the Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers shall be known as the Mining and Exploration Division.

Section 2. The objective of the Mining and Exploration Division shall be to furnish a medium of cooperation between those directly engaged in metal mining and those engaged in the technologies of mineral exploration. To further the objective toward a common goal and advance these branches of the mining industry, this Division will promote and publish papers, arrange meetings and programs, and encourage education on any subject related to these phases of the industry.

Article II
Members

Section 1. Any member of the American Institute of Mining, Metallurgical, and Petroleum Engineers and the Society of Mining Engineers may become a member of this Division by indicating to the Society of Mining Engineers in writing his desire to do so.

Article III
Officers

Section 1. *Division Officers.* There shall be a Chairman, Assistant Chairman, three Vice Chairmen, and a Secretary equitably representing the membership of the various fields of interest within the Division. The Division offices should be rotated to represent the various fields of interest as qualified candidates become available.

Section 2. *Nomination and Election of Officers.* The Nominating Committee shall report to the Chairman on or before May 15 the nominees for Chairman, Assistant Chairman, three Vice Chairmen and two nominees each year for the post of Society of Mining Engineers Director. These directors should be chosen to provide adequate representation on the SME Board from each of the fields covered by the Division. In turn the Chairman shall arrange for the publication of the names submitted in the July issue of MINING ENGINEERING and shall also advise the Secretary of the Society of Mining Engineers of the nominations. Other nominations for office may be made and forwarded in writing to the Secretary of the Society up to August 15, for publication in the October issue of MINING ENGINEERING. If such nominations are made, letter ballots will be prepared for return not later than November 1. If no other nominations are received the candidates nominated by the Committee will be considered elected and will take office at the Annual Meeting.

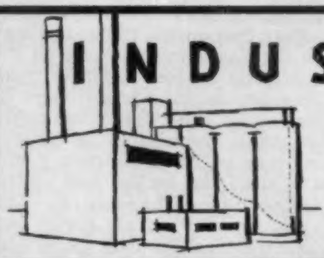
Article IV
Committees

Section 1. *Executive Committee.* The Executive Committee shall consist of the officers listed in **Article III,** *Section 1,* the Chairman of each of the Unit Committees, and the most recent Past-Chairman of the Division. For the transaction of business the presence of a quorum of not less than five (5) members shall be necessary. If there are less than the required quorum of five (5) present at the meeting, the meeting shall be held and the minutes circulated to the entire Committee for approval.

Section 2. *Unit Committees.* There shall be a minimum of five (5) permanent Unit Committees representing: 1) Underground Mining, 2) Open Pit Mining, 3) Geology, 4) Geophysics, and 5) Geochemistry. Other Committees representing any phase of the industry may be created at the discretion of the Division Chairman, as the need arises. The Committee Chairmen shall be appointed by the Chairman of the Division upon the advice of those members interested in that particular phase of the industry. Should no selection be made by the members, the Chairman shall appoint the Committee Chairmen.

Section 3. *Nominating Committee.* The Nominating Committee shall consist of a minimum of eight (8) members, including the immediate Past-Chairman, the past

(Continued on page 62)



INDUSTRIAL MINERALS NEWSLETTER

Dear Members of IndMD:

J. K. Brooke, our Pacific Southwest Vice Chairman and coordinator for the Division with the Southwest Minerals Industry Conference, has tendered the following program for IndMD papers at the Conference meeting, April 24 and 25, 1961, at Las Vegas:

At the afternoon session April 24, C. F. Clausen, 1961 IndMD Chairman, will be session chairman and Fred Lohse will be co-chairman. Papers scheduled for this meeting include: *Limestone Resources of Southern California* by Clifton H. Gray, Jr.; *Heat Exchange and Double Cyclone Preheaters* by Ray R. Adams; *Permanente Cement Co. Deposit, Permanente, Calif.* by Edward B. Connors; *Blue Diamond Gypsum Mine* by H. L. Waldhausen, Jr.; and *Recent Exploration for Asbestos in California* by Salem J. Rice.

An IndMD breakfast is being organized for April 25. The session to follow will have R. H. Feierabend, 1960 IndMD Chairman, and Lauren Wright as co-chairmen. Papers to be presented are *Industrial Minerals Development in the Central and Southern Rocky Mountains Region* by Alfred L. Ransome; *A Summary of Industrial Minerals and Rocks in the State of Alaska* by John Y. Cole; *History of Brucite-Magnesite Mining at Gabbs* (tentative title) by Augustus M. Dixon; and *Geothermal Power in California* by James R. McNitt.

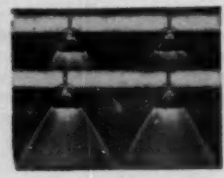
An afternoon session will have as co-chairmen Ian Campbell and J. K. Brooke and will present *Economic Aspects of the Interruption to Diamond Production in the Congo Republic* by A. F. Daily; *Salinas of Guerrero Negro* by C. L. McClaughry; and *A Brief Survey of the Barite Deposits of California* by F. Harold Weber, Jr.

This Southwest Minerals Industry Conference is shaping up as a very interesting meeting, one worthy of the support of all IndMD members. Plan to attend.—*John S. Holland.*

Note

All Division mail to **Leon Dupuy** should be addressed to his home:

2475 Virginia Ave., N. W.
Washington 7, D. C.



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M & E Bylaws

(Continued from page 60)

Unit Committee Chairmen, and two (2) others to be selected by the Chairman of the Division.

Article V

Duties of Officers

Section 1a. The Chairman shall preside at the annual business meeting of the Division, which will take place at the time of the Society of Mining Engineers Annual Meeting. He shall call other meetings as required to transact the business of the Division. He shall be responsible for coordinating the programs for the meeting of the Division. He shall name the Chairmen of the Unit Committees, as set forth in **Article IV,** *Section 2.* He shall name the Secretary of the Division.

Section 1b. The Assistant Chairman shall keep in constant touch with all actions of the Chairman and shall act in his stead whenever the Chairman is unable to function or attend any meetings. He shall assist the Chairman as directed.

Section 1c. The Vice Chairmen shall be designed as follows: 1) Vice Chairman, Publications; 2) Vice Chairman, Program; 3) Vice Chairman, Membership. It shall be the duty of each Vice Chairman to coordinate the Unit Committees' activities under his classification. Each shall act as a liaison officer between the Division and the appropriate officer or committee of the Society of Mining Engineers. They shall at all times keep the Division Chairman and Assistant Chairman informed of their activities.

Section 1d. The Secretary of the Division will send out meeting notices, take the minutes of the Executive Committee or business meetings, follow instructions of the Chairman of the Division and Secretary of the Society of Mining Engineers, and perform such other duties which may be necessary for proper functioning of the Division.

Article VI

Duties of Committees

a. The Executive Committee shall be charged with the responsibility of conducting the affairs of the Division in a business-like manner. It shall have the authority to appoint a Chairman Pro Tem to act when any of the officers are unable to function.

b. The Unit Committee Chairmen shall appoint from members interested in their particular unit, Unit Committee members on: 1) Publications, 2) Program, 3) Membership, plus 4) any other members for special investigations or projects that they may see fit to investigate. Each Unit Committee Chairman shall inform his committeemen of the Vice Chairman in charge of their specific activity and also inform the Vice Chairman of the member appointed. The Unit Committee Chairman may allow the committee member to report directly to the Vice Chairman or may act as an intermediary. In either case, the Unit Committee Chairman is responsible for proper functioning of his committee members. It shall also be the duty of the Unit Committee Chairman to canvass the members of his group and to report to the Division Chairman the name of the member selected to succeed him as Unit Committee Chairman. This shall be done at least two months in advance of the Annual Meeting.

c. The Nominating Committee shall meet to make their selections in time to comply with the deadline set in **Article III,** *Section 2.* Division members having candidates should submit the name of the candidate to the Committee Chairman prior to May 1 of each year. The Committee shall give due consideration to all names submitted.

Article VII

Funds

Funds received by or assigned to the Division shall be deposited with the Secretary of the Society of Mining Engineers at New York, or at any other place and under the responsibility of an officer of the Division as deemed necessary by the Executive Committee for the efficient operation of the Division. The Secretary or other responsible party shall submit a statement of receipts and disbursements to the Chairman of the Division in time for a report for the annual business meeting. Disbursements from Division funds may be made by the Secretary of the Society of Mining Engineers upon authorization of both the Division Chairman and the Division Secretary, for such purposes as have been authorized by the Executive Committee of the Division. Exceptions to this general rule can be made by order of the Executive Committee of the Division.

Article VIII

Meetings

Section 1. The Division shall meet at the same time and place as the Annual Meeting of the Society of Mining Engineers for the election of Division officers and for the transaction of any other business; and at other times and places as may be determined by the Executive Committee. Notice of such a meeting must have been sent to the members of the Division through the regular mail, or must have been published in MINING ENGINEERING to reach the members at least 20 days before the meeting.

Section 2. For the transaction of any business, the presence of a quorum of not less than twenty (20) members shall be necessary.

Section 3. At the annual business

M & E Bylaws *(Continued)*

meeting of the Division the order of business shall be as follows: The meeting will be called to order by the retiring Chairman, who will transact any necessary business and present any reports or call for any deemed necessary. He will then introduce the new officers and turn the meeting over to the new Chairman. The new Chairman will announce the names of the new Executive Committee, appoint a nominating committee, and transact such other business as necessary.

Article IX

Amendments

Proposals to amend these Bylaws shall be made in writing to the Executive Committee of the Division and signed by at least ten (10) members. They shall be considered by the Executive Committee and announced to the members through the columns of MINING ENGINEERING, together with any comments or amendments made by the Executive Committee thereon. They shall be voted upon at the Annual Meeting of the Division, or by letter ballot, as may be directed by the Executive Committee and are subject to approval of the Board of Directors of the Society of Mining Engineers and the Board of Directors of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

Nathaniel Arbiter to Receive Richards Award

Nathaniel Arbiter, 1961 recipient of the Robert H. Richards Award, is professor of mining engineering in the Henry Krumb School of Mines, Columbia University, his alma mater. Before taking his place in the academic field, Mr. Arbiter was associated with the Battelle Memorial Institute in Columbus, Ohio, and Phelps Dodge Corp., Arizona and New York.

In naming Mr. Arbiter for the award, the AIME Board of Directors gave the following citation:

"For his contributions to the Mineral Industries and to the advancement of our profession, as an Educator, as a Research Scientist, and as an Engineer. His ability to analyze and solve difficult problems and his willingness to assist others has brought to AIME and the Mineral Industry of the world, advancements in flotation and other beneficiation processes."

PREPRINTS AVAILABLE

From SME Fall Meetings

The following list of papers will be available until Nov. 1, 1961. Coupons received with the 1961 dues bill and those distributed at the 1961 Annual Meeting are valid for these papers. Purchased coupon books are honored at any time.

Coupons books may be obtained from SME for $5 a book (10 coupons) for Members or $10 a book for Nonmembers. Each coupon entitles the purchaser to one preprint.

COAL DIV.—ST. LOUIS SECTION MEETING, September 1960

60F300 Stripping Machinery Mass, Overburden Volumes Relationships by *Henry Rumfelt.*
60F301 Oklahoma-Arkansas Coals by *B. L. Curry.*
60F302 Shaft Sinking and Lining in the Southern Illinois Coal Field by *J. W. MacDonald.*

AIME-ASME JOINT SOLID FUELS CONFERENCE, October 1960

60F400 Mechanical Mining in Low Seam Mines by *Clyde H. Storey.*
60F401 Our Knowledge of Underground Gasification in the USSR and a Comparison with US Processes by *C. D. Pears and Milton H. Fies.*

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Mayo's new, cast steel coupler for narrow gauge mine cars couples instantly on tangent or curves. Safe, self-centering link completely eliminates all hazards of hand couplings. Only a little more expensive than link-and-pin, it more than pays for itself by preventing accidents. If you can save one smashed finger, you've got these couplers paid for. Easily installed by bolting to existing cars. Write for Bulletin No. 21.

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Around the Sections

• More than 180 people heard Neele E. Stearns, director of the University of Chicago's executive program, address the November 2 dinner meeting of the **Chicago Section.** His subject was *The Education of Engineers for Management.* As usual, the meeting was held at the Chicago Bar Assn.

• The **Colorado Section** met September 15 at the Petroleum Club in Denver, where they heard Joe Seep, head of the Rokite Dept., Mine & Smelter Supply Co., discuss Rokite, a trade name for an abrasion-resistant ceramic material hot-sprayed onto various surfaces by a process comparable to metallizing. Mr. Seep distributed samples of the product and showed colored slides illustrating various applications. A lively discussion followed. Mr. Mariacher presented a membership award to Mr. Davis, who had obtained five new members.

On October 5th the Section was invited to attend a symposium on Rock Mechanics, sponsored by the Denver Petroleum Section, at the Hilton Hotel. Afterward a dinner honoring the officers and directors of AIME was held at the Petroleum Club in Denver, followed by the Colorado Section's regular monthly meeting. The Denver Petroleum Section members and wives were invited. Among the guests were: AIME President-Elect R. R. McNaughton and Mrs. McNaughton, J. S. Bell, A. B. Cummins, C. C. Long, J. P. Hammond, E. O. Kirkendall, C. J. Hicks, and Denver Petroleum Secretary T. Ferry and Mrs. Ferry. AIME President J. L. Gillson gave a brief but comprehensive talk on the Institute's objectives and problems.

The speaker of the evening was W. W. Fertig, executive secretary of the Colorado School of Mines Alumni Association. His subject was *The Romance of Mining.* Mr. Fertig, who previously enjoyed a varied and successful career in mining in the U. S. and abroad, related many interesting mining stories from around the world.

• **The Student Chapter of the University of Alaska** recently visited the gold room of U. S. Smelting Refining & Mining Co. at the company's Alaskan headquarters in Fairbanks. The company operates several large dredges in Alaska and produces most of the state's raw gold. Headed by their chapter president, Blair Wondzell, students observed metallurgical practices in processing raw placer gold preparatory to its sale to the U. S. Mint as bullion. Donald J. Cook, Dean of the School of Mines, and J. Crawford, manager of the company's Alaskan operations, assisted in guiding the tour.

• Members of the **Central New Mexico Section** heard Clifford J. Hicks, western field secretary, and AIME President Joseph Gillson speak at their monthly dinner meeting held October 14 in Grants, N. M. About 75 members and guests were present for the occasion. Among the guests were eight members of the **Cooney Mining Club,** student chapter of the New Mexico Institute of Mining and Technology. The club is planning an active program for the year under the direction of Robert Jones, president.

• The **Burkhart Mining Society** of Virginia Polytechnic Institute reports its newest member is Elizabeth Lenore Gibbs, who has enrolled as a freshman in the school's department of mining engineering.

Elizabeth Lenore Gibbs, a freshman at Virginia Polytechnic Institute, has become a member of Burkhart Mining Society.

• The **Montana Section** met October 22 at the Montana Club in Helena. A short business meeting followed a social hour and an excellent prime rib dinner. Ben F. Wake, industrial hygiene engineer, Division of Disease Control, State of Montana, was speaker of the event. In his talk, *The Role of Industrial Hygiene in Modern Industry and Principles of New Plant Design for Health Protection,* Mr. Wake stressed that the design process is the primary and proper phase in any operation to improve industrial hygiene in new industrial units. He also made the point that his office acts as a consultant by making recommendations to help managers of industrial sites solve their hygiene problems.

The annual Great Falls meeting of the **Montana Section** was held November 12 at the Howdy Restaurant. The Anaconda Co. was host to the 37 members at a social hour and steak dinner. Following a short business meeting, Charles F. Hill, mechanical superintendent of the Great Falls

Some members and guests at the Central New Mexico meeting. Front row: C. E. Osborn, chairman, Larry Dykers, Joseph L. Gillson, Tom Boyer, Robert Jones, and Floyd J. Ballentine. Back row: William Bonnichsen, Frank Wedekind, James Richardson, James Baldwin and Kenneth Schroer.

Among those shown with Joseph L. Gillson during the October meeting of the Central New Mexico Section are: Roshan Bhappu, C. E. Osborn, Tom Boyer, A. W. Elden, Kenneth Schroer, and Frank Wedekind. Seated: Robert Jones, president, Cooney Mining Club; James Baldwin; and Larry Dykers.

Reduction Plant of The Anaconda Co., gave a talk entitled *The Reorganization of the Mechnical Department at the Great Falls Plant.* A lively question and answer session followed.

• The fall meeting of the **Pennsylvania-Anthracite Section** was held October 28 in the Town and Country Room of Gus Genetti's Hotel and Motel outside of Hazleton. Members had their choice of roast beef or South African lobster tail for dinner and, as a seasonal treat, homemade pumpkin pie for dessert. Ralph A. Lambert, chief mining engineer of the Pennsylvania Department of Mines and Mineral Industries, discussed research projects which have been conducted through the Department's Coal Research Board, with special emphasis on the anthracite phase of the research program.

• The **Maricopa Subsection** (Arizona Section) met October 6 at the Westward Ho Hotel in Phoenix. R. S. Jensen, president of Metallizing Co. of Los Angeles, was guest speaker. The subject of his illustrated talk was *Flame Spraying of Metals.*

The Section's November meeting was held on the 3rd, also at the Westward Ho Hotel. G. Robert Prescott, research engineer for C. F. Braun & Co., described some of the more severe materials problems in the petroleum industry and the potential application of some Fe-Cr-Al alloys in solving the problem. The talk was illustrated by slides.

• The **Minerals Industries Society** at the University of Illinois held its first meeting October 11. Because of meeting conflicts only 34 students attended. The program consisted of a panel discussion on the three branches of AIME and the advantages in becoming associated with such an organization, both as a student and in later professional work.

Annual joint banquet of the AIME Student Chapter and the Civil Engineering Society of Wisconsin State College and Institute of Technology on the Platteville campus.

The Minerals Industries Society is composed of students in the mining, metallurgical, and petroleum curricula.

• The traditional annual joint meeting of the **San Francisco Section** and the **Student Chapters** of **Stanford University** and the **University of California** was held on the University of California campus on November 9. The University of California Student Chapter was this year's host. The meeting began with an open house at the Hearst Mining Building and proceeded to Spengers Fish Grotto for cocktails and dinner. The program was presented by students of the University of California and consisted of the following papers: *Specific Heat of Liquid Bismuth* by Howard Bell, metallurgy; *Dislocation Structures of Molybdenum* by Ray Benson, metallurgy; *Photographic Stress Analysis of Sandstone* by Ayetkin Timur, mining and petroleum; *Induced Polarization in Natural Rocks* by Norman Kevil, mining and petroleum; *Knudsen Cell Method of Determining Vapor Pressures at High Temperatures* by David Schulz, ceramic section; and *Microstructures and Mechanical Properties of the Lithium and Magnesium Fluoride Systems* by William Scott, ceramic section. Sixty members and 22 students attended the meeting.

Officers and advisors plan year's program for the University of Illinois Minerals Industries Society. From left, standing: George Vytanovych, secretary; Robert Wittman, president; William Bottomley, vice president; Walter Collins, treasurer; Ronald Bradle, Engineering Council representative. Seated, B. G. Ricketts and G. R. Eadie.

• The **AIME Student Chapter of the Wisconsin State College and Institute of Technology** joined with the School's Civil Engineering Society for their annual banquet on the college campus at Platteville this fall. Royce Biddick, on the staff of the ESSO Research and Technology Corp., spoke on the peace-time use of atomic explosives and described projects on which they could be used. He compared the cost of atomic blasting with that of standard explosives and showed slides depicting radiation problems. James Ballant, a senior in civil engineering, and Thomas Christian, a senior in mining engineering, received the WIT Association awards, which were presented by Milton Melcher, dean of the technology division.

• The **Washington, D. C. Section** met at the Broadmoor Hotel, November 1, where members heard a program about recent studies and exploration in Antarctica. The subject drew an unusually large attendance from the Section—about 90. T. O. Jones, director of the Antarctic Research Program of the National Science Foundation, opened the program with a talk entitled *National and International Aspects of Antarctic Research.* He was followed by Phillip M. Smith, also a member of the Antarctic Research Program, who illustrated his lecture, *Science Explores a Continent,* with colored slides. John Mulligan of the U. S. Bureau of Mines gave an illustrated talk called *Antarctic Coal Geology Studies* and completed the program with the film *Geological Observations and Field Methods in the Taylor Dry Valley Area, South Victoria Land,* for which he provided the narration.

• The **Morenci Subsection** (Arizona Section) met November 1 at the Longfellow Inn, where they heard Leonard Klein and John H. Davis, Jr., both of Phelps Dodge Corp., discuss *Air Reforming of Natural Gas for Use in the Copper Industry.* This process represents a major advance in copper smelting and fire-refining practices.

Cooper H. Wayman has left U. S. Steel Research Center as supervising technologist in refractories and mineral technology to become project chief in physical chemistry with the U.S. Geological Survey at Denver.

James K. Richardson has relinquished his position as vice president and general manager of Glover Associates (Canada) Ltd. in Montreal to open an office in San Francisco as a consultant.

The Colorado School of Mines recently announced the appointment of George V. Keller as assistant professor of geophysics and physics. He was a former geophysicist with the U.S. Geological Survey.

Richard F. Brooks, who recently resigned as director of Mining and Raw Material Development at Gladding, McBean & Co., has become associated with Desert Minerals Inc. and its affiliate, American Mineral Co., as vice president.

Research-Cottrell Inc. recently announced the appointment of John E. Schork as director of manufacturing. He has been with the company since 1956, when he went to work as a project engineer. Since then he has served on a number of company projects and committees as assistant to the president.

Personals


F. J. HALLER


W. M. FIEDLER


E. L. BEUTNER


R. M. CRUMP

Francis J. Haller, a consulting engineer in the iron ore industry, has been named a director and consultant of the Jubilee Iron Corp. The firm has extensive iron ore properties in the Labrador Trough and is embarking on an extensive drilling and exploration program there. It is believed that Mr. Haller's wide experience in the iron ore industry will prove of great value in expediting the current program.

Jones & Laughlin Steel Corp. recently announced the appointment of **William M. Fiedler** to the newly created position of assistant general manager—planning and development, Ore Mines and Quarries Div. **Edward L. Beutner,** formerly assistant chief geologist, has been named to succeed Fiedler in the post of chief geologist of Jones & Laughlin. **Robert M. Crump,** formerly staff geologist, has been named chief mining engineer.

William B. Hays has taken a job with the Illinois Division of Highways at Decatur.

G. Herzog, manager of Texaco's Bellaire laboratory, recently was issued patents on improvements in a radiation detector cathode and improvements in radioactivity earth exploration.

PROPOSAL FOR AIME MEMBERSHIP

I consider the following person to be qualified for membership and request that a membership kit be mailed to him:

Name of Prospective Member:

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Address

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Name of AIME Member:

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CHANGE OF ADDRESS AND PERSONALS FORM

CHANGING YOUR ADDRESS? Don't forget to notify us six (6) weeks before you move, if possible, to insure uninterrupted receipt of your publications and correspondence. Please fill in the form below and send it to: J. F. Lynch, Asst. Treasurer AIME, 29 West 39th Street, New York 18, N. Y.

Name ....

Old Address ....

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New Address ....

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....

PERSONALS: Please list below your former company and title and your new title and company (or new work) for use in MINING ENGINEERING. (Copy deadline for personals items is six weeks before date of issue.)

Former Company ....

Former Title .... Length of Time There ....

New Company ....

New Title .... Date of Change ....

....

Any recent activity that would be of interest to members:

....

....

....

The American Society of Mechanical Engineers has recently honored **Carroll F. Hardy,** associate director of the Marketing Dept. of the National Coal Assn., by electing him a Fellow.

Charles E. Schwab has been appointed president and chief executive officer of The Bunker Hill Co., filling the position left vacant by the death of John D. Bradley. He has served as the company's general manager of Kellogg, Idaho Operations since the beginning of 1960 and was named a vice president in April. As president, he will continue to make his headquarters in Kellogg. He has been associated with Bunker Hill since 1944, when he came to work as a mining engineer.


C. G. EDWARDS


C. E. SCHWAB

Charles G. Edwards has resigned as operations manager of Gulf Land Enterprises Inc. to accept a position as general manager with Port Richey Mining Corp.

C. W. Davis has become president of Southern Coal Producers' Assn. with headquarters in Washington, D. C. He was formerly executive secretary of Bituminous Coal Operators' Assn.

Yoshiteru Suzuki, of Dowa Mining Co. Ltd., has been transferred to Akita prefecture, in the northern part of Honshu Island, where he is general manager of Hanaoka mine, a new copper mine and mill construction. He was formerly general manager of the company's Akagane mine at Funabashi near Tokyo.

J. S. Wakeman has returned to the U.S. to become a metallurgical engineer in the Research Dept. of M. A. Hanna Co., at Hibbing, Minn., after five years as section engineer at Moa Bay, Cuba, for Freeport Nickel Co. He is presently engaged in developing agglomeration techniques for iron ore concentrates from various sources.

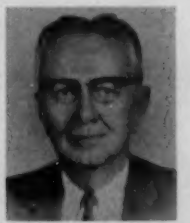
Following a two-year tour of duty with the U.S. Army, **William I. Nissen** has taken a job with the U.S. Bureau of Mines as an extractive metallurgist in Salt Lake City.

Lloyd S. Cluff has joined Woodward-Clyde & Sherard as an engineering field geologist. After receiving his B.S. degree in geology from the University of Utah and completing one quarter of graduate work, he went to work for Lottridge-Thomas & Associates as exploration geologist on a special project. It was on completion of this project that he assumed his present position.

With the transfer of Lithium Corp. of America Inc. general offices from Minneapolis, **Fremont F. Clarke,** vice president—mining and manufacturing, has moved to New York City.

Alan H. Larson, formerly an engineer with Climax Molybdenum Co., has joined the U.S. Geological Survey as a mining engineer.


T. L. CAREY


W. J. NOCK

Armour Agricultural Chemical Co., Atlanta, has named **Thomas L. Carey** director of exploration and mining development. Prior to his recent appointment, he served in the company's Chicago office as mining consultant.

American Smelting & Refining Co. recently announced the appointment of **Walter J. Nock** as vice president in charge of the company's Mexican Div. He was formerly general manager of Asarco's Mexican Mining Dept.

Following graduation from the Royal School of Mines, London, **R. M. Baird** has gone to Nigeria, West Africa, as a mining engineer with A. O. Nigeria Ltd. He is presently engaged in prospecting work.

R. S. Riley has taken a job as senior accountant with the Utah Div. of Kennecott Copper Corp., following his graduation from Stanford University.

After pulling up stakes to move to Lima, Peru, to work for Marcona Mining Co. as mine engineer, **Thomas F. Clemens** was obliged to return to the U. S. at the end of five weeks because of illness in the family. He has taken a job as mining engineer with Calaveras Cement Co. in Redding, Calif.

J. H. Eastman, formerly with Pato Consolidated Gold Dredging Ltd., Colombia, South America, has been transferred to Vancouver, B.C., to work for Canadian Exploration Ltd. as a technical assistant to management. Both companies are members of the Placer Development Ltd. family.

Lute J. Parkinson, head of the mining engineering department of the Colorado School of Mines, has been named consulting engineer for the Roberts Tunnel, part of the Denver water diversion project.

Texas Gulf Sulphur Co. recently announced the transfer of **Frank E. Tippie** from the company's headquarters in New York to Moab, Utah.

Tej Bhan Malhotra, group agent for Macneill & Barry Ltd., recently took a three-month leave of absence to enroll in a course at the Administrative Staff College of India.

Robert G. Wiese, Jr., formerly a graduate student at Harvard University, has taken a job as exploration geologist with New Park Mining Co.

Richard W. Ziminski has joined Standard Lime & Cement Co. as a mine engineer. He was formerly shift foreman for The New Jersey Zinc Co.


D. L. FINGER


U. K. CUSTRED

American Cyanamid Co. recently announced the promotion of **U. K. Custred** and **D. L. Finger, Jr.,** to new positions in the company's phosphate mining operations at Lakeland, Fla. Mr. Custred was named mines manager and Mr. Finger was named superintendent of Cyanamid's Sydney mine. Both men worked as shift supervisors before their promotions.

Richard A. Smith, 84, who retired from his post as state geologist with the Michigan Geological Survey in 1957, is dividing his time between his cottage on Gun Lake, Mich., from May to November and his home in Orlando, Fla., the rest of the year.

American Metal Climax Inc. recently announced the appointment of **George H. Cleaver** as manager of market research, Amco Div. Before joining American Metal Climax he was market editor for the McGraw-Hill publications *Engineering and Mining Journal* and *E&M Metal and Mineral Markets.*

William Dean Cunningham, a geologist with Minerva Oil Co., has transferred from Illinois to the company's new office in Grand Junction, Colo., to engage in an exploration program for beryllium.

R. B. Tempest, Jr., civil engineering officer with the deputy commander for civil engineering, Andersen Air Force Base, Guam, is anticipating a return to the U. S. after 33 months in Guam.

The appointment of **Milton F. Williams** as manager of the new raw materials research laboratory nearing completion at U.S. Steel's

personals

continued

Geneva Works was announced recently by the chief metallurgical engineer of Columbia-Geneva Steel Div. Mr. Williams has served as supervisor of U.S. Steel's research laboratory in Duluth for the Oliver Iron Mining Div. since 1953.

Louis D. Piana, formerly commercial engineer with Mercantile Metal & Ore Corp., has developed and engineered a laminated-fiberglass outboard motor boat with retractable wheels and has founded his own company, Amphibious Boat Inc., of which he is president.

Robert T. Banks, who retired in 1958 as manager of Joy Mfg. Co. in New York after 40 years with the company, now has his permanent home at The Cedars, Lopez Island, Wash. He is presently handling the properties of the Assets Corp. of Utah and recently completed writing *Handbook of Drilling and Blasting Methods in Open Pit Operations.*

Holly W. Sphar has been elected to the newly created position of vice president—planning and commercial development, according to a recent announcement from Consolidated Coal Co. In his new capacity Mr. Sphar, who has been vice president and treasurer, will be responsible for long-range planning for the company both in coal and other investment opportunities, including commercialization of projects originated by the company's Research & Development Div.

The University of Arizona honored four distinguished members of the mining industry at a dinner held in conjunction with the Symposium on Surface Mining Practices October 17. The Medallion of Merit, commemorating the University's 75th anniversary, was presented to: **Frank H. Buchella,** vice president of Magma Copper Co. and San Manuel Copper Co.; **Darrel Gardner,** general manager of Magma Copper Co., **John A. Ware,** president of Tarr, McComb & Ware; and **Carrol P. Donohoe,** president and general manager of Cananea Consolidated Copper Co., Cananea, Mexico, who was named to receive his award in absentia.

D. L. BOGGS, JR.

B. A. BRAMSON

Delbert L. Boggs, Jr., has been appointed southeastern sales representative for Long-Airdox Co., with headquarters in Birmingham. This marks the first time the company has had a personal representative in this territory. Prior to his appointment with Long-Airdox, Mr. Boggs was mine foreman for the Alabama Power Co.

Bernard A. Bramson has accepted appointment by the UN as deputy project manager of its mining mission to Chile. His last foreign assignment was at Johannesburg, where he served the U. S. Department of State as regional minerals officer for southern Africa. Since his retirement from the diplomatic service last year, Mr. Bramson has been technical advisor to Philipp Bros., a division of Minerals & Chemicals Philipp Corp., in New York.

Bernie Pratte, *center, general manager of the Pacific Div. of Harnischfeger Corp. of Milwaukee, announced recently that the company is moving its West Coast manufacturing plant and sales-service headquarters to larger facilities outside Los Angeles.* **John Zimmerman, Jr.,** *left, mayor of Norwalk, and* **Tom Archibald,** *right, vice president of the Norwalk Chamber of Commerce, extend their welcome to Mr. Pratte.*

Stephen S. Klatsky, formerly a member of the staff of Columbia University, has taken a job with M. A. Hanna Co. as a mining engineer.

Following his graduation from the Royal School of Mines, London, **Otto H. Gilbert** returned to South Africa to take a job as mining engineer with Premier (Transvaal) Diamond Mining Co. Ltd.

E. R. Phelps, who recently resigned as president of The Pittsburg & Midway Coal Mining Co., has been appointed chief engineer of Peabody Coal Co. He will be in charge of mine engineering, exploration, and development of new mines. At the same time it was announced that **C. P. Arnold,** vice president and chief engineer, has been appointed vice president and director of engineering for Peabody.

J. S. Quinn was recently appointed manager of the Omaha district office of Allis-Chalmers Mfg. Co. He was formerly manager of heavy industry sales in the company's St. Louis district. He will be succeeded in that position by **R. A. Frazee,** who has been a representative in the St. Louis district since 1950.

John M. Martin was recently elected a vice president and member of the executive committee of Hercules Powder Co. He has been general manager of the company's Explosives Dept. and a member of the board of directors since 1953. He is a nationally recognized authority in the field of high explosives and has been responsible for the establishment and growth of Hercules' Chemical Propulsion Div.

Jack D. Hayes, formerly assistant general manager of the Explosives Dept., has been named general manager to succeed Mr. Martin.

William F. Saalbach, manager of recruitment for Consolidation Coal Co., recently received his Ph.D. in business administration from the University of Pittsburgh. He graduated from the University in 1943 with a degree in metallurgical engineering.

It was announced recently that **F. W. Bloecher, Jr.,** has been promoted to assistant manager of the mining chemicals department of Cyanamid International. In his new post Mr. Bloecher will coordinate the efforts of Cyanamid's research and market development units in the mining chemicals field with the company's technical representatives outside the U.S. and Canada. He was formerly sales engineer with Cyanamid International.

Michael E. Woakes has resigned his position as geologist with Mufulira Copper Mines Ltd. and returned to England from Mufulira, Northern Rhodesia.

Obituaries

George Waterman

An Appreciation by H. F. Yancey

The mineral industry lost one of its strongest members and staunchest supporters with the death of George Waterman of Seattle on Sept. 22, 1960. His untiring interest in the industry was shown best by his attendance at most of the annual meetings of the AIME (Member 1936) and the American Mining Congress. Locally he was active in the North Pacific Section, AIME, serving one year as chairman, and also in the same capacity for one of the best Pacific Northwest tri-sectional regional meetings.

Born in Sanborn, Minn., Mr. Waterman came to Seattle in 1923. In this year he founded the Manufacturers Mineral Co., of which he was president until he sold the company in 1958. However, he still retained control of the mineral deposits used by the company through a subsidiary, the Mineral Products Corp., of which he was president at the time of his death. He was a past member of the Board of Governors of the American Mining Congress, past president of the West Coast Mineral Assn., and a member of the Seattle Rotary Club and the Rainier Golf and Country Club.

George's friendliness, warmth, and counsel will be missed by a wide circle stretching across the country.

Raymond Brooks (Member 1919) died August 12, 1960, in Lusaka, Northern Rhodesia, at the age of 80. From 1945 until he was stricken with pneumonia, two months before his death, he headed a company that operates a copper mine at Mumbrwa. He first went to Africa in 1920 as manager of western mines for Union Minière du Haut Katanga in the Belgian Congo and in 1923 went to work for Rhodesian Congo Border Concession Ltd. in Northern Rhodesia. From the late 1920's through the 1930's, Mr. Brooks maintained a consulting practice, with offices in new York and Johannesburg. During World War II he served with the Metals and Minerals Warfare Service in Washington, D. C. Mr. Brooks was born in Chicago and was a graduate of Princeton University. Following graduation in 1904, he began his career mining and prospecting in Montana, Wyoming, and Colorado.

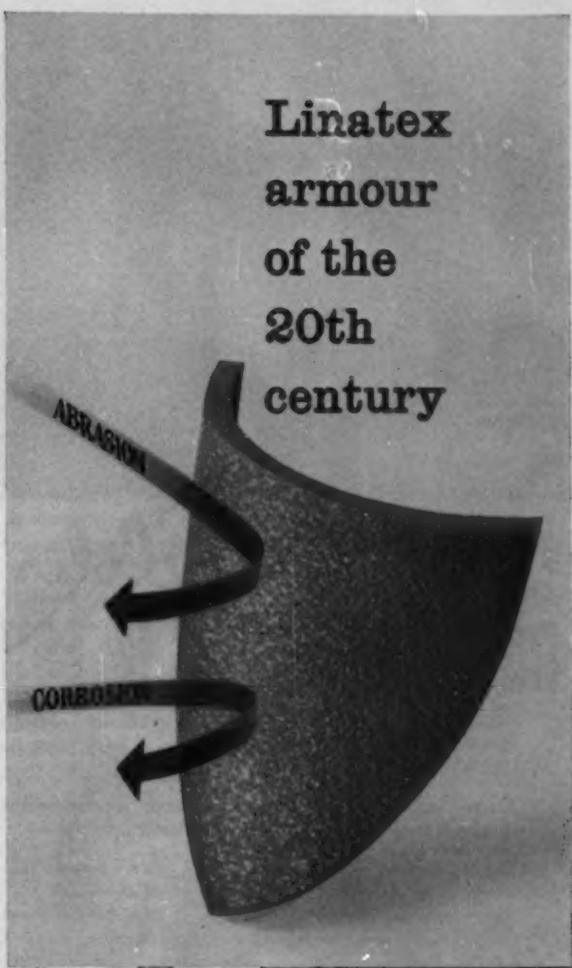
William E. Crawford (Member 1916) died recently at the age of 79, in Alhambra, Calif. He was born in Litchfield, Ill., but moved to California in his youth. He was a graduate of Stanford University. Much of his career was spent in Mexico. Before his retirement in the early 1950's, he was assistant mill superintendent for Quemont Mining Corp. Ltd., Noranda, Quebec.

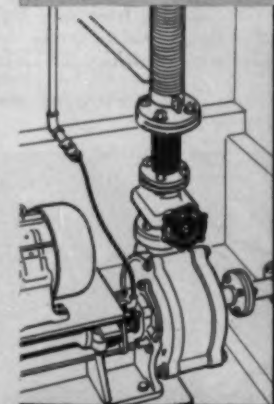
J. H. Fletcher (Member 1925) died July 18, 1960, at Huntington, W. Va., at the age of 72. He was born in Wayne, Ill., and graduated from the Armour Institute of Technology in Chicago. His first job was in the drafting room of Arnold Co. Engineers, Chicago. Until just before his death, Mr. Fletcher had worked in Chicago, where his company had headquarters. The company office was moved to Huntington, W. Va., in July.

S. T. Harrison (Member 1940), 70, died July 30, 1960, at Clearwater, Fla. He was born in Duluth and attended Michigan College of Mining and Technology and Northwestern University. He began his career in private practice as a mining engineer and surveyor in 1912. In 1934 he began his association with J. L. Shiely Co. which lasted until his retirement this past year. For the last couple of years he served the company in a consulting capacity.

Stanley W. Johnson (Member 1952) died in Mexico at the age of 32 on March 25, 1960. A citizen of the U.S., he was born in Parral, Mexico. Following graduation from Harvard in 1949, he went to work for American Smelting & Refining Co. as a junior engineer at the company's Parral and Charcas units. At the time of his death he was associated with Minera San Martin, S.A. de C.V.

(Continued on page 70)





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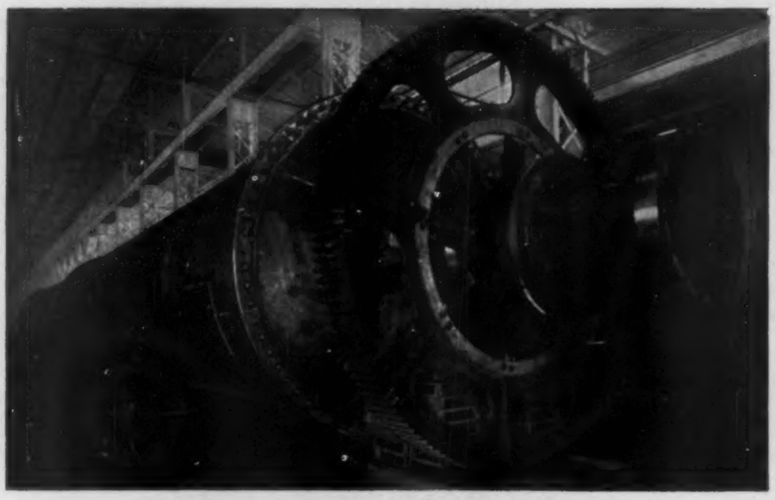

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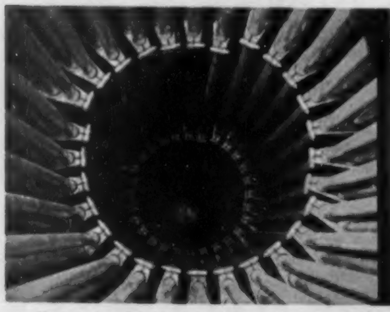
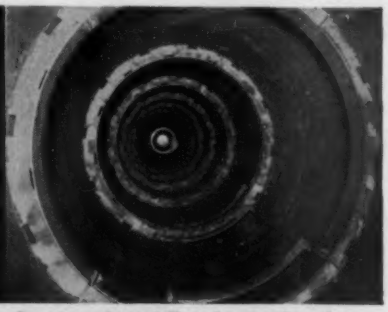


Interior of a water-tube cooler. Longitudinal banks of tubes provide maximum cooling surface for minimum floor space.



Interior of partially-submerged cooler with gravity-controlled scrapers maintaining clean shell surface for high-rate heat transfer.

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Obituaries

(Continued from page 69)

George B. Harrington (Legion of Honor Member 1907) died May 13 in a Chicago hospital at the age of 79. For many years a leader in the coal industry, he had been a director of the National Coal Assn. from 1927 to 1932 and from 1936 to 1952 and served on its executive committee for 18 years. In 1944 he was awarded the AIME William Lawrence Saunders Gold Medal for distinguished achievement in mining.

Mr. Harrington was born in Wilmington, Del., and was a graduate of Princeton University and the Massachusetts Institute of Technology. He began his career in Mexico, working at various mining operations. In 1907 he returned to the U.S. and entered the coal field as an employe of Stone and Webster in Renton, Wash. After seven years he went to Illinois to examine some old coal properties; this was a prelude to the formation of the Chicago, Wilmington & Franklin Coal Co., of which Mr. Harrington became president. Under his direction the company became an outstanding example of first-class engineering, design, and management. At the time of his death he was a director of Materials Service Corp.

Paul Hett (Member 1940) 61, formerly assistant general manager at Kennecott's Nevada Mines Div., died July 31 in Ogden, Utah, of a heart condition that caused his retirement in the spring of 1955. He first went to work for Kennecott in 1923 as a sampler. Born in Lead, S. D., he received his professional education at the South Dakota State School of Mines. Graduating in 1918, he had to defer his career until 1922, when he went to work as a mining engineer for Trojan Mining Co.

Ross B. Hoffmann (Member 1913) died June 1 at the age of 87 following a long illness. A native Californian and graduate of the University of California, Mr. Hoffmann lived in the state for the greater part of his life. During the early days of his career, however, he was actively engaged in general mine examination work which took him to Russia, Siberia, South America, Alaska, Mexico, various parts of the U.S., and British Columbia. From 1914 to 1918 he lived in New York, returning to California in the spring of 1918.

George G. Kapantais (Member 1960) was killed in an auto accident July 3, near West Yellowstone, Mont., shortly after his graduation from the University of Utah. He was born in Chicago, May 20, 1937.

Necrology

Date Elected	Name	Date of Death
1913	Murl H. Gidel	Mar. 18, 1960

1943	Edmond V. Given	Sept. 7, 1960
1915	Ira L. Greninger	Unknown
1926	Robert W. Hughes	Sept. 1960
1907	C. O. Lindberg (Legion of Honor)	Sept. 2, 1960
1927	John F. Magee	Aug. 3, 1960
1920	B. W. W. McDougall	Feb. 3, 1960
1934	Frank W. Millard	July 8, 1960
1960	Robert J. Miller	Unknown
1922	F. Wm. Nobs	May 21, 1960
1941	Merle F. Otto	Aug. 4,1960
1932	Carel Robinson	Sept. 20, 1960
1944	Gust J. Salmi	Unknown
1928	Quincy A. Shaw	May 8, 1960
1924	H. A. Wagner	Apr. 11, 1960

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Proposed for Membership
Society of Mining Engineers of AIME

Total AIME membership on November 30, 1960, was 34,636; in addition 2,971 Student Members were enrolled.

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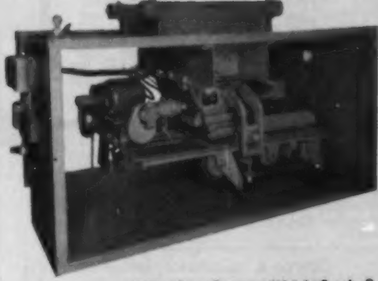

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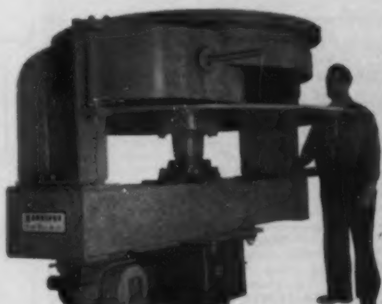

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Continued on page 74

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Case History From:
FRIA, Leading Alumina Producer
Tests showed high alumina extraction could be made at coarse grind. Advantages were: lower grinding costs and a coarse sand residue from classifier which kept soluble loss to only a trace.
PROBLEM: Can coarse, high density, fast-settling bauxite ore be agitated in commercial operation?
Screen Analysis: —3/16" x 8 mesh 7%
— 8 mesh x 16 mesh 21%
—16 mesh x 32 mesh 23%
—32 mesh x 49%
Dilution: 3:1
Feed: Bauxite ore, sp. gr. 3.0 and sodium aluminate solution sp. gr. 1.35, Temperature 105° C.
Residue: Sp. Gr. 3.5 due to iron minerals. Settling rate maximum 78 feet per minute.
FRIA contacted leading manufacturers of Agitators, selected several units for pilot plant tests. Only DENVER Agitators maintained coarse solids in suspension and properly agitated pulp.
SOLUTION:
Agitators: 18 Denver Agitators, (2 banks of 8 ea., 2 standby units.)
Propellers: 96" diameter.
Tank Size: 22' diameter x 20' deep
Power Requirements: 70 HP consumed
RESULTS: Entirely satisfactory operation plus economy of coarse grind and coarse sand tailings residue.
This is only one example of many advantages with coarse agitation. We invite your inquiry.
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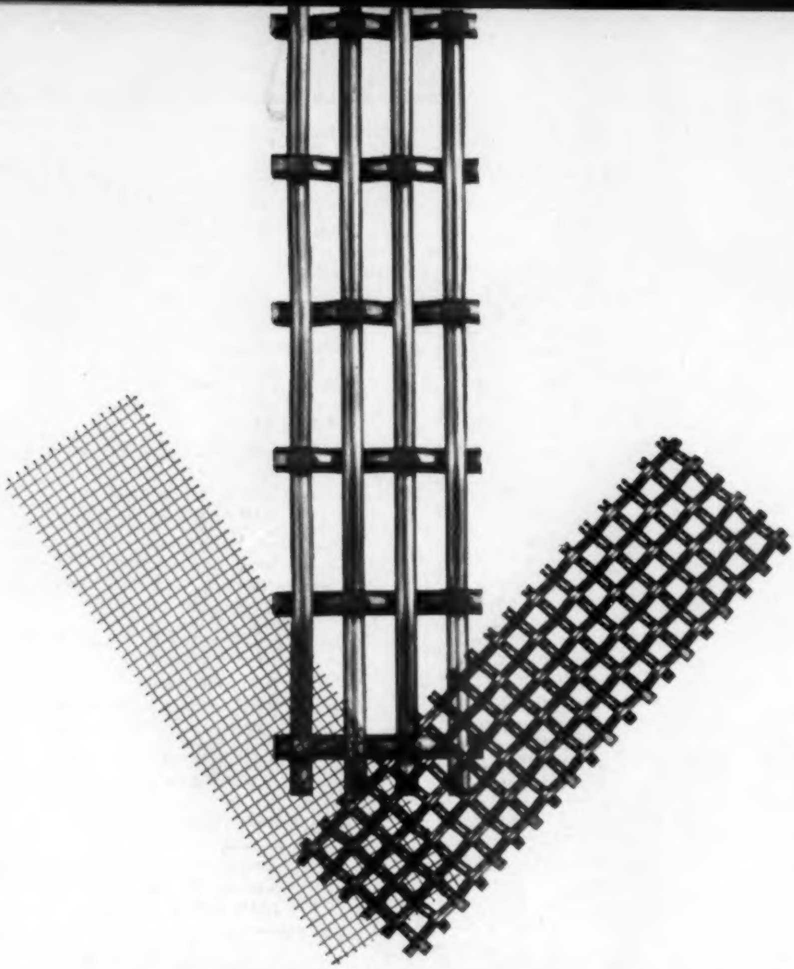

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